



Special Double Issue

THE LAND

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form a backdrop to
a Colorado landscape

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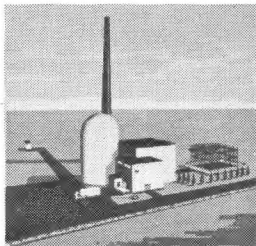
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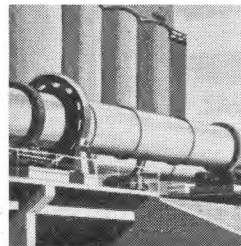
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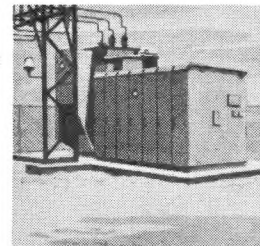
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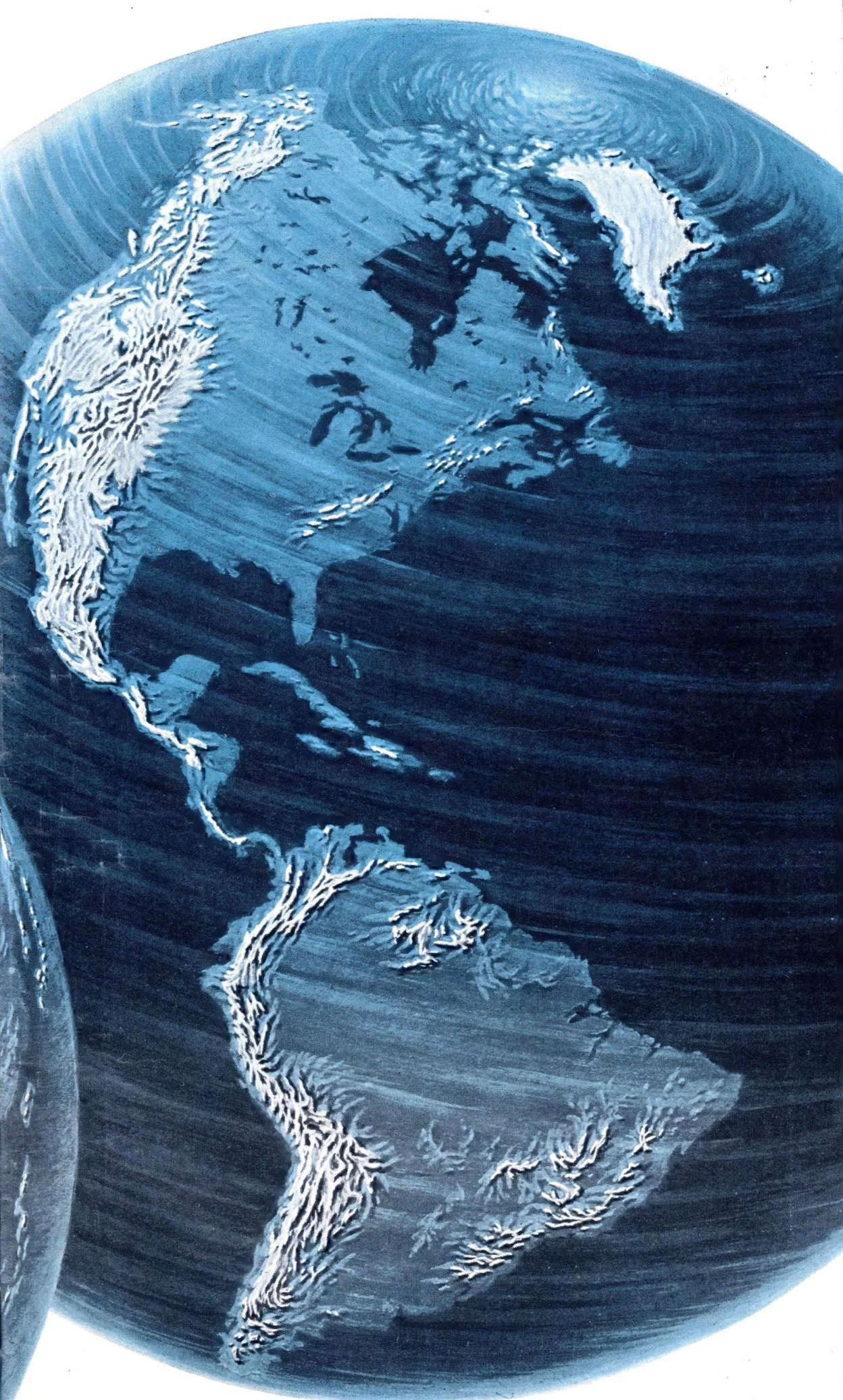
A Special Double Issue

THE LAND

Sweeping across this earth from pole to pole, soaring to the height of 29,141 feet, sinking to 1,286 feet below sea level, the land masses of seven continents cover almost one third of our globe. This special double issue is devoted to the wondrous sights and the fascinating facts of The Land, and is divided (Table of Contents, *right*) into sections on the land's awesome beginnings, the majestic mountains, the abundant forests, the eerie deserts and the frozen poles, with another section on the marks man has made on the land. This issue, together with the one on The Sea (Jan. 28, 1963, Vol. 34, No. 1), comprises a spectacular study of our planet earth.



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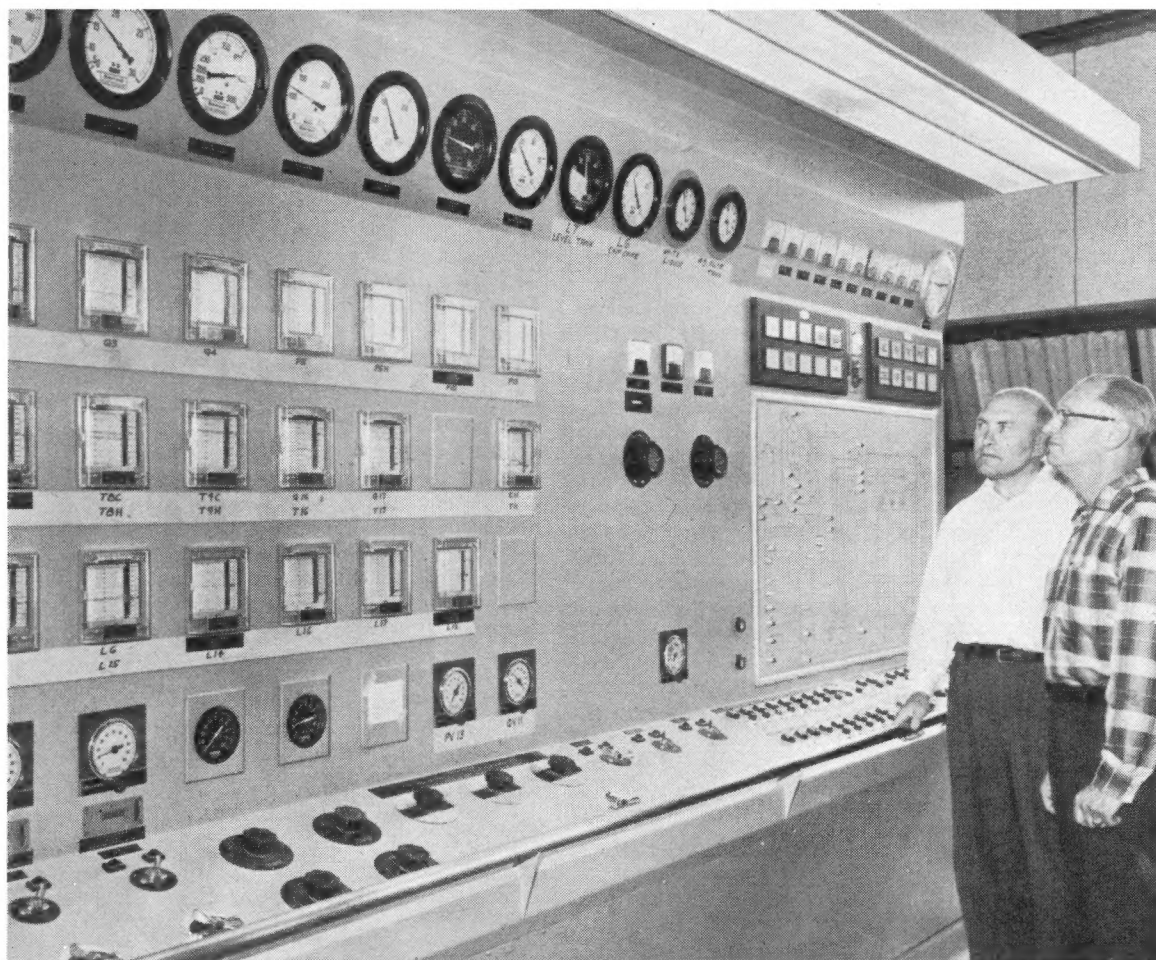
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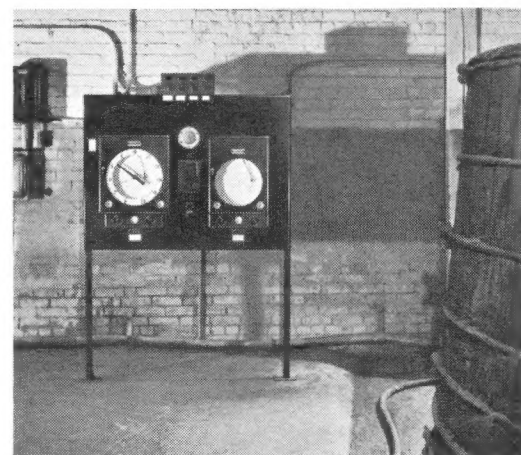
To help you make this complex and crucial decision, Honeywell has prepared a report to management setting forth a pro-

gram that simplifies the entire matter. If you have an industrial process—continuous, batch or a combination—involving control of variables such as temperatures, pressures or flows, you may find the answers to your automation problems in this report.

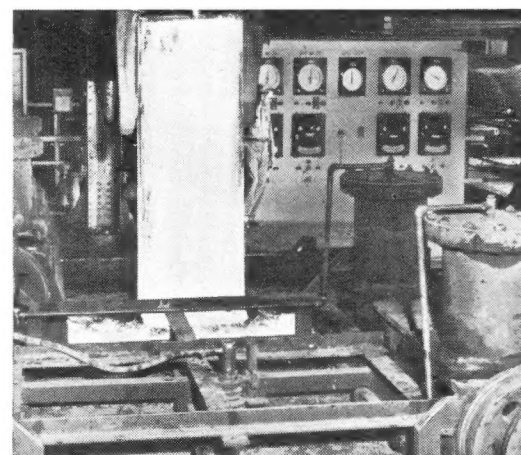
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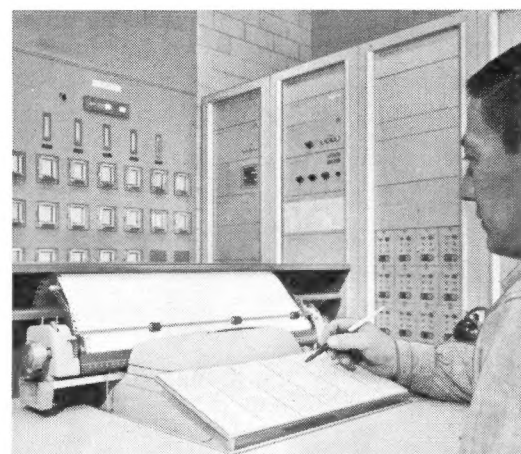
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Once we are grown up it'll be... By the way, our dads think just as we do. Don't be angry, we will turn to face the teacher again in a moment. But when it's a choice it's easy to decide for a Mercedes-Benz.



MERCEDES-BENZ

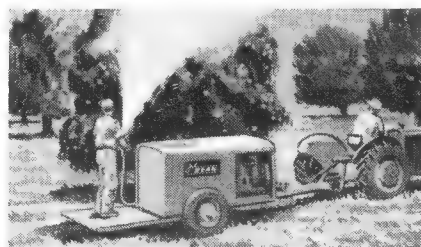
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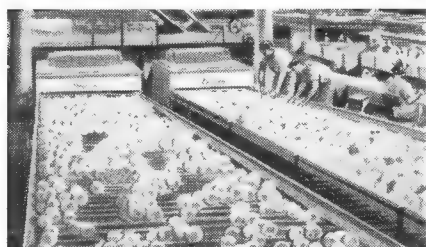
Agricultural Chemicals and Equipment

Insecticides, fungicides and herbicides to protect growing crops; chemicals for fertilizers; grain fumigants; hand and power sprayers.



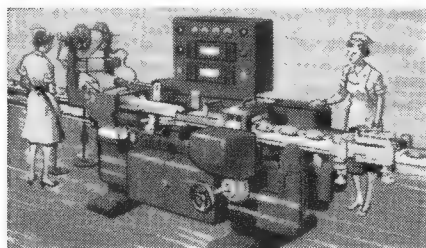
Pumps and Irrigation Systems

Deep well pumps; portable and automatic sprinkler irrigation systems for crops; pumps for food preparation and processing plants.



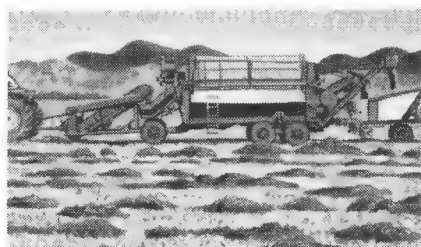
Fresh Fruit and Vegetable Processing

Packing house equipment and protective processes for fresh citrus, deciduous fruits and vegetables; citrus juice extractors.



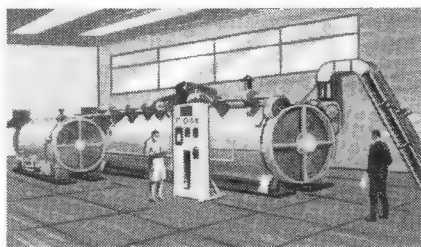
Packaging Machinery and Handling Equipment

Machinery for forming and filling packages of foil, paper, heat-seal films; set-up paper box and carton equipment; egg packing systems; conveyors and automatic pallet loaders.



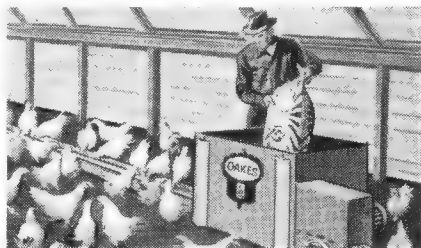
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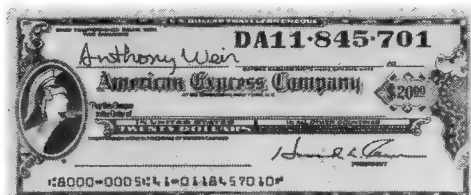
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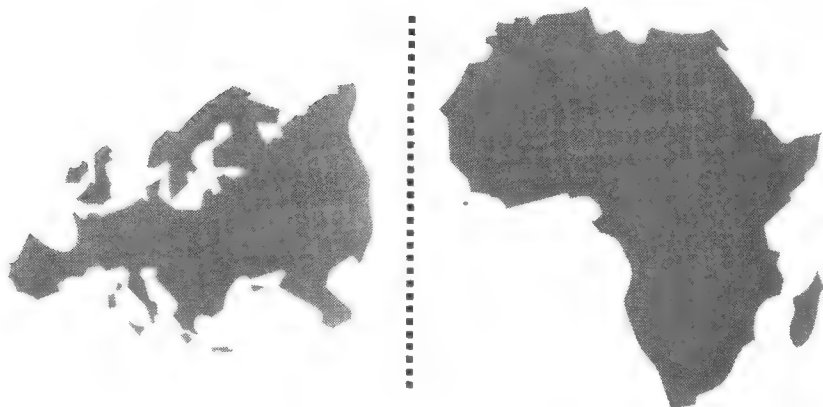
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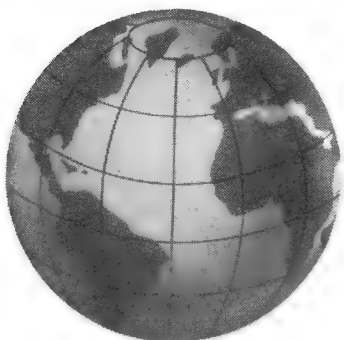
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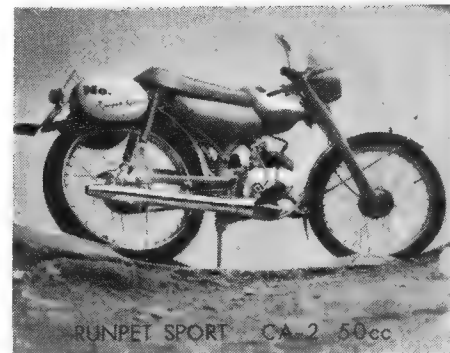
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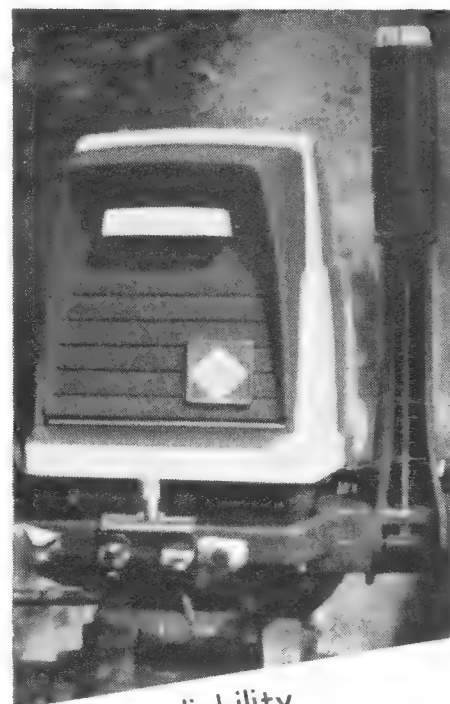
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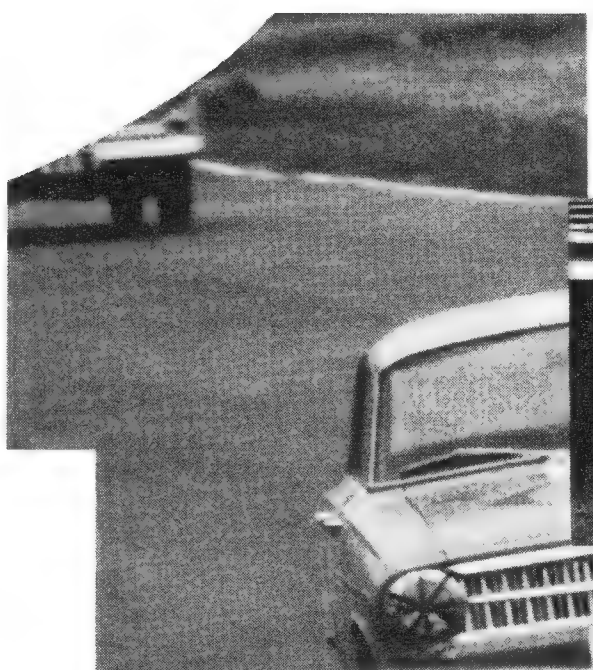
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TOYOTA 700



TOYOTA CROWN



TOYOPET TIARA

The place: Japan's new Suzuka road racing circuit, a hilly, twisting 6-kilometer torture chamber for cars. The event: the Japanese Grand Prix races on May 3 and 4, 1963 — first international race in Japan to have the sanction of world racing authorities.

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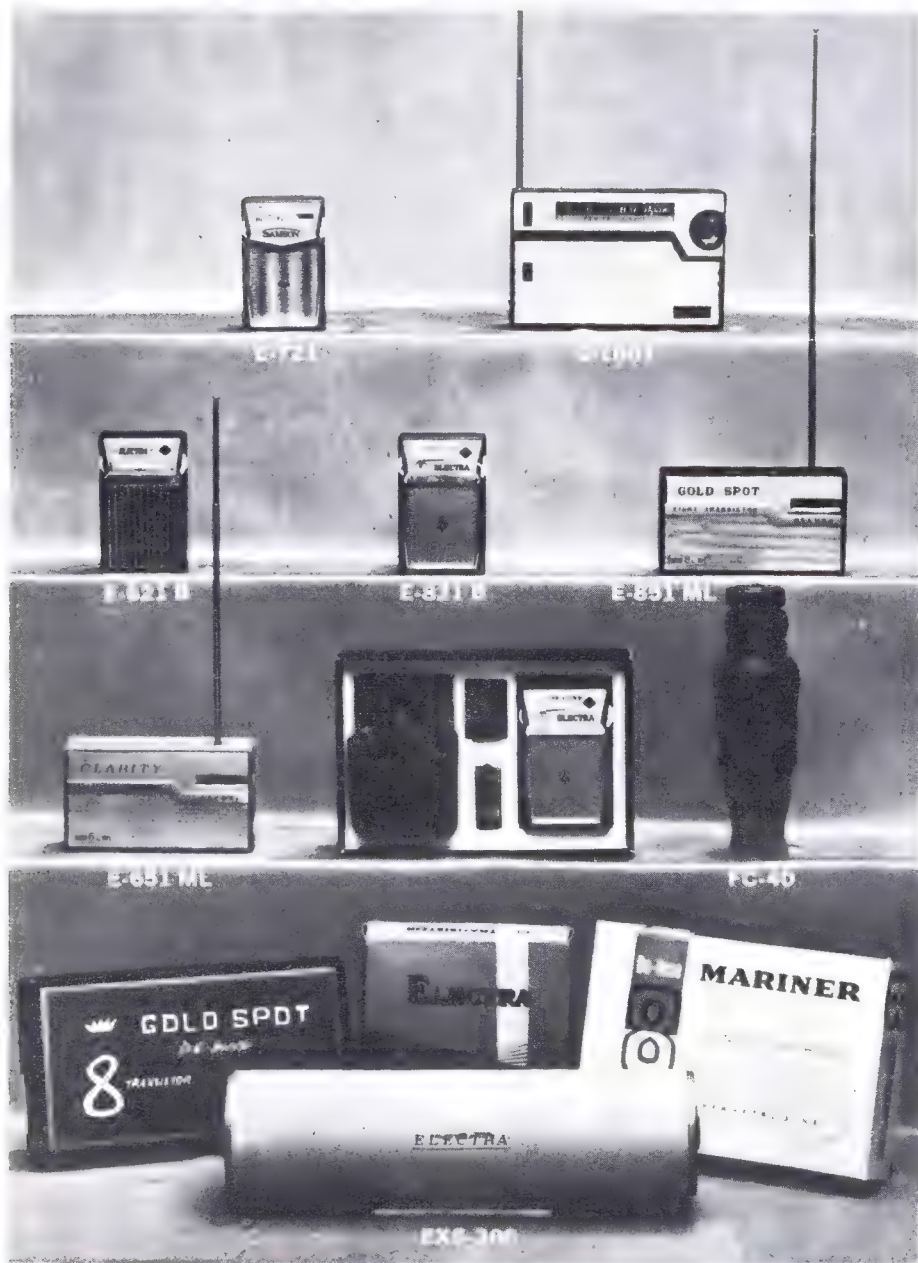
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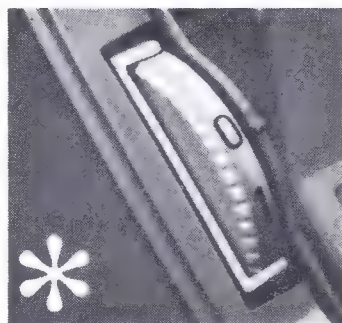
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The Earth's Chaotic Beginnings Are Still Debated

HOW THE LAND



Man has always postulated a Creation. Thus Genesis, in its mighty opening phrases, speaks of how our land had its origins: "In the beginning . . . the earth was without form, and void; and darkness was upon the face of the deep. . . ." As modern scientists probe deeper into the origins of the earth, they have tended to substantiate the Biblical verse as a fairly accurate account of what probably occurred some four and a half billion years ago when the

earth came into being. For the new earth was indeed a ball of chaotic matter, haloed by light gases, careening down its dusty orbit. But no one knows just how or when the earth acquired the continents as they exist today. So fragmentary is the evidence of the first 20 per cent of the earth's history that it can and has been interpreted in totally differing ways. One geological theory—the classic one—holds that the earth was once a sphere of molten rock (very

WAS FORMED

LIFE
INTERNATIONAL
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much as it is depicted in the painting above), its mass heated to incandescent liquidity by the squeeze of gravitation and by internal radioactivity. During this molten phase, the metallic iron present sank toward the core and the lighter silicate material collected on top and congealed to form the protocontinents, precursors of the land as we know it today. In violent disagreement with the molten earth hypothesis are those who think the planet coalesced as

a frigid mass and heated up internally only very slowly, never becoming molten on the surface at all. In this theory, the protocontinents were the gradual accumulation of volcanic materials hardening on the surface of the cold sphere. Still other geologists discard both these theories of hot and cold, molten versus hard earth, believing that the explanation of how our land was formed lies somewhere in the middle—perhaps hidden forever in the darkness of time.



THE PRIMEVAL OCEANS were created when the temperature of surface rocks fell to the point where water vapor could condense. And as the earth's first rains began they started the unending process of erosion, sweeping

minerals down to the ever-increasing sea. Present-day oceans cover two-thirds of the earth's surface and average two miles in depth. Within their 330-million-cubic mile volume, the seas enfold trenches even deeper than Everest is high.



THE PRIMEVAL LANDSCAPE took form over unknown millions of years after the first cooling of the earth's crust, as the bleak aboriginal rock was continually altered by the dual forces of mountain building and erosion.

No sooner did new mountains arise than falling rain began to whittle them away, flattening their pinnacles, furrowing their ridges and shoulders, carving deep canyons and widening valleys. And all the time, as the forces of

THE COMING OF THE DEEP WATERS

As man has forever wondered about the beginnings of the land upon which he lives, so he has tried to pinpoint the origins of the seas which gave him life. But because scientists have never been able to agree whether the earth began as a fiery molten sphere or a frosty globe, their conclusions about the beginnings of the primeval oceans are just as conflicting. All geologists agree that the oceans were quite small at first, although they disagree as to how these waters were formed. Some believe that water vapor emitted by the volcanoes on the young earth created the primeval oceans when it fell as rain (*left*). Others maintain that the earth's waters were initially stored at its poles in gigantic caps of ice, which thawed only when the cool, young sun developed into the hot adult star it is today and warmed the earth. No matter how it all began, nearly all geologists are now convinced that the oceans grew to their present size as a result of further water vapor that escaped from the earth's interior. And while the immensities of the ocean basins were being filled, their floors were deformed by internal forces similar to those that metamorphosed the protocontinents into the familiar land masses of today.

For the endless cycles of uplift and erosion of the last 80 percent of the earth's history are still going on. The cycle begins with the patient erosion of a protocontinent, as the rains inexorably disintegrate the rock

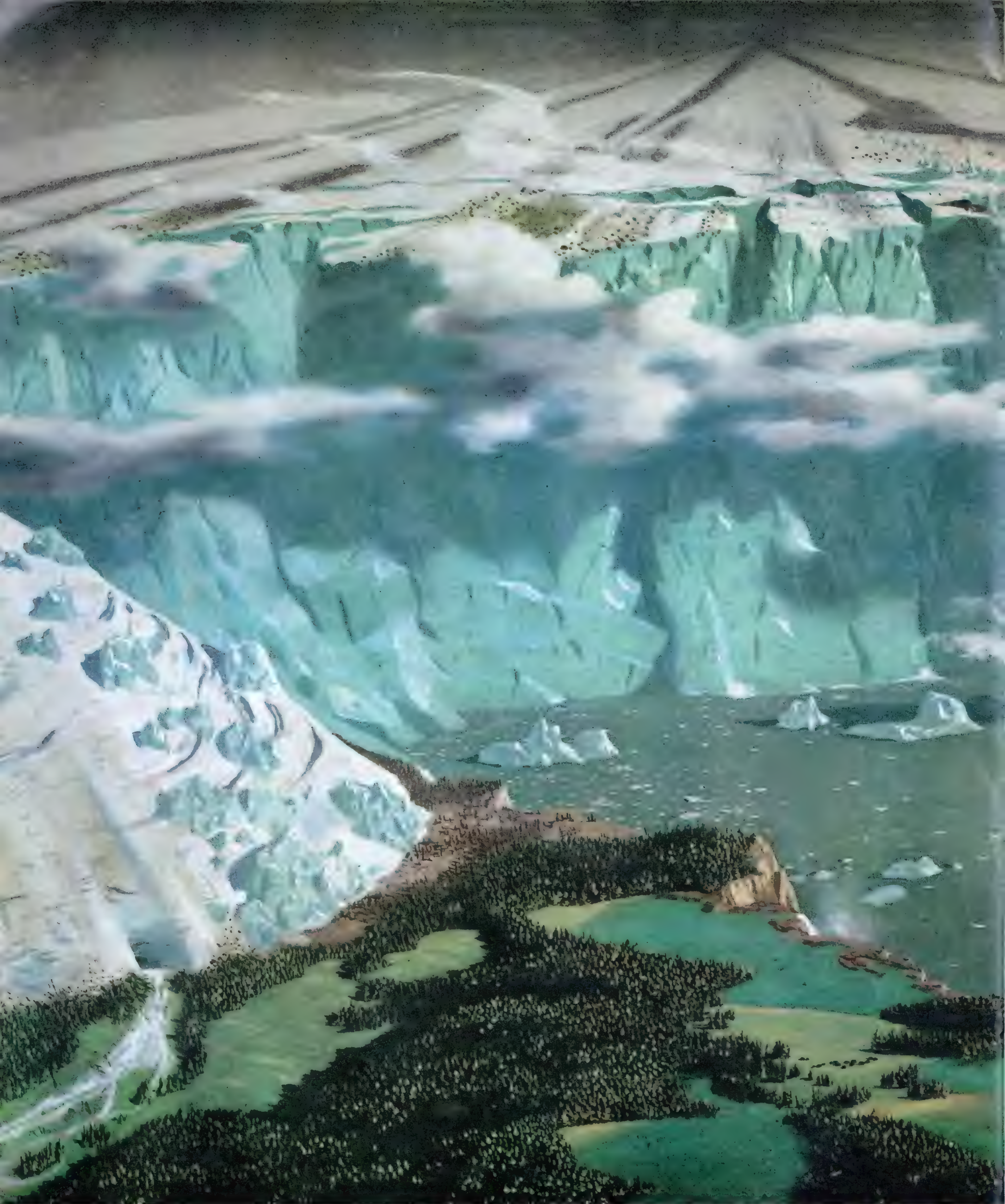
and wash the sediment into the sea. Much of this eroded sediment settles in mammoth undersea trenches which slash the ocean bottoms along the edges of the continents. Some believe these trenches are sucked into the earth's surface by molasseslike currents of molten rock stirring sullenly in the earth's mantle. Its sediment burden, baked to rock by underground heat and pressures, is eventually thrust to the surface as a mountain range, enlarging the area of the older continent. Delicate evidence of this cycle is found in the sea shells studding rocks high in the Alps. And portents of the future have been revealed by recent seismic soundings showing a sediment-filled trench several thousand feet deep off the Atlantic coast of North America.

But while this cycle is in one phase at one edge of a continent, it may be at a different phase at another, and a third stage somewhere else. Thus, throughout geologic time, periods of mountain building have alternated with longer periods of relative calm, when the rains drilled away at the mountaintops, carving deep canyons and gorges, sweeping the substance of the mountains down to the sea. What seems to be an eternal battle for supremacy between the forces of uplift and erosion—to make this a land of unbroken high peaks or endless flat plains—is in reality a delicate balance between the two forces that enables the earth to keep the familiar features man has always known.



destruction slowly did their work, volcanoes brought forth new lava from the uneasy depths, ever changing the size and shape of the protocontinents. At some unknown point in this shadowy time, and through some unknown

process, life appeared. One of the earliest forms of life is visible in this painting: the purple bacteria which give color to the lake shown at the far left, just as they give a reddish tinge to certain lakes on the earth today.

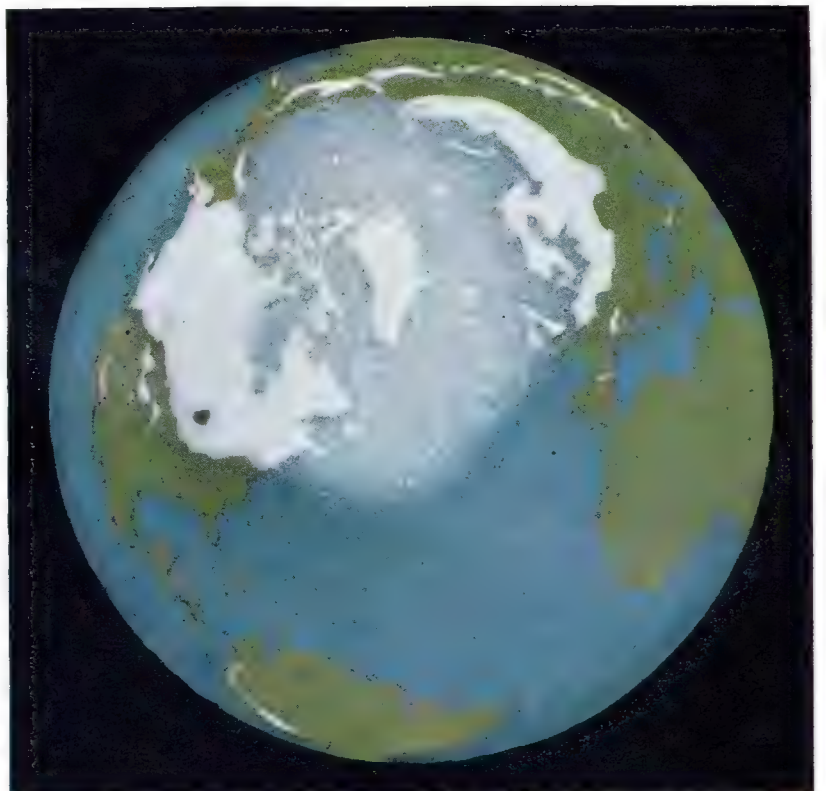


THE HUGE GLACIERS moved across the earth throughout geologic time, sculpturing the final scene—planing valley floors, scouring the soil from fertile lands and leaving behind them new rivers and lakes. The first ice age probably

refrigerated the earth a billion or more years ago. Since then glaciers have advanced and retreated many times. Each time the ice sheets, sometimes 4,000 feet thick at their centers, have changed the face of the land, crushing



trees and vegetation. When they reached the end of the land they sheared away in grim, glittering tongues, like those shown above, glowering briefly above the sea, then crashing piecemeal into the water in gigantic icebergs.

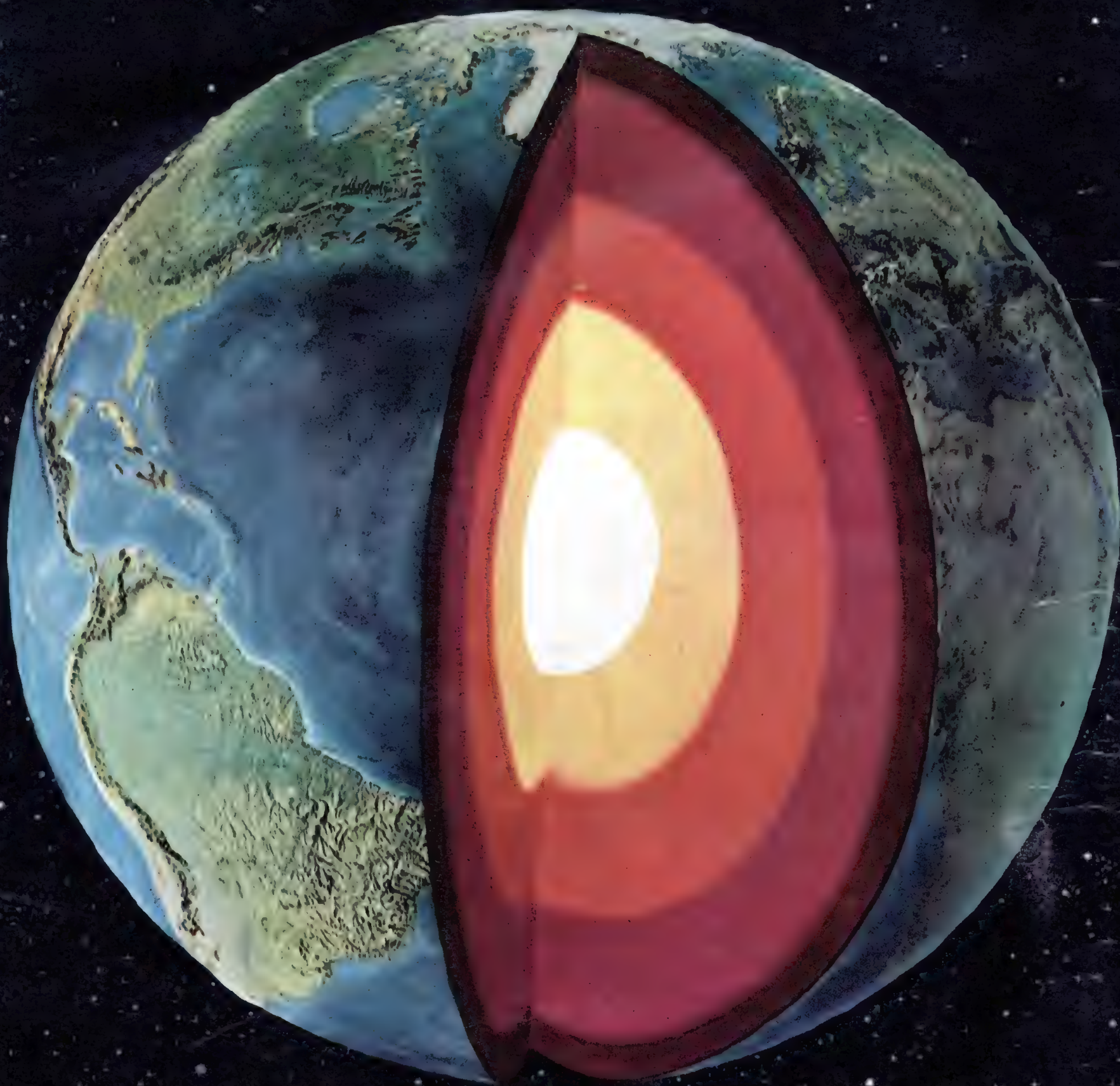


THE LAST GREAT ICECAP, shown on the globe above, began spreading south about a million years ago, glaciating northern Europe, Asia, North America and the heights of both hemispheres. Its last shrinkage began 20,000 years ago.

THE MARCH OF GIANT GLACIERS

Geology reveals that many epochs of mountain building have been accompanied by one of glaciation. Mountains impede the flow of air; land bridges that arise in times of continental uplift divert the warm currents of the oceans, producing local climatic extremes. But mountains are not the sole cause of glaciers. The causes of the earth's periodic ice ages constitute one of the deepest enigmas of geohistory. Some scientists have explained them by atmospheric factors—changes in the composition of the atmosphere. Others have suggested astronomical causes, like fluctuations in the intensity of solar radiation or shifts in the position of the earth with respect to the sun. Yet no one factor suffices, and perhaps all operate together.

The last and possibly greatest series of all ice ages began one million years ago. Glaciers covered more than one fourth of the earth's land surface. Spread over millions of square miles, thousands of feet thick, these stupendous ice masses overlay mountains and valleys alike, and during successive advances and retreats transformed the land on a colossal scale. The mountains crushed beneath this vast weight re-emerged with none of the intricate sculpture wrought by valley glaciers, but rather with smooth summits and rounded ridges. In addition to remodeling the highlands, the ice sheets created lakes and rivers by the thousands in North America, Europe and Asia. Today we are just emerging from the great advance which reached its climax about 20,000 years ago. But as recently as 12,000 years ago great ice caps still covered the whole of northern Europe. The glacial cover in the Swiss Alps may have been as much as a mile deep, which means that only the tops of the highest mountains jutted above it and the rest of the country was drowned under trillions of tons of solid ice, with every one of today's green valleys filled to the brim. In the last 200 years there has been a marked retreat of the glaciers until today, hotels in Switzerland built around 1900 to command vistas of ice have no glaciers in view. And in the Arctic and Antarctic, ice packs recede yearly. If the present icecaps melt completely, the sea level would rise by 200 feet or more—enough to drown such cities as New York and London and submerge all other low-lying areas.



THE MOLTEN EARTH BELOW



In ages to come, as in ages past, the relentless forces of glaciers, wind and water and the imprisoned fury of the primal fires within the earth's interior will repeatedly revise the features of man's world. Yet how and why these elements work as they do is as yet only imperfectly understood. For any study of the origins of the earth must begin with a knowledge of its present state; and it is the paradox of geophysics that its greatest mysteries lie practically under our feet. So far man has been able to penetrate only about a thousandth of the distance to the terrestrial center. But the bits of evidence at hand seem to indicate that the earth's interior, if laid bare by a slice (*left*), would reveal a structure like that of a titanic fruit. The outer skin is a rock crust

only three to 30 miles thick. Beneath the crust lies a solid silicate shell—"the mantle"—2,000 miles thick. The core is a sphere of molten iron, 4,000 miles in diameter (about the size of Mars) and probably about half the temperature of the sun's surface. The mantle seems to be both rigid and plastic, white-hot where it meets the core and probably red-hot throughout. Local pressure changes several hundred miles deep in the upper mantle may cause it to liquefy into molten rock or lava. Often the lava boils to the surface quite peacefully. But the volcano Parícutín (*above*) was born in dramatically sudden violence on a Mexican cornfield in 1953. Spewing hundreds of tons of gassy lava every minute, its peak grew to 450 feet in just two weeks and to 930 feet in just eight months.





A LAKE OF LAVA heaves turgidly in a crater (*opposite*) in the Congo's Virunga. This range's eight main peaks reach 10,000 feet or more; two can be seen aglow at night from 20 miles. Natives call them the "Abode of Devils."

A BLANKET OF ROCK, basaltic lava laid down by a Congo volcano, shows how some landscapes were formed. Vegetation on the slopes and lava fields of long-dead volcanoes shoots up in wild luxuriance in the rain-rich tropics.

FLOWS THAT KILL AND RESTORE

A look into the maw of the crater shown opposite suggests only one side of the dual role volcanoes have in the history of our land. This seething pit, one of the world's few permanently molten lakes, calls up the names of Vesuvius, Krakatoa, Pelée—all synonyms for death and destruction. But volcanoes are also indispensable to life. The phoenix of mountains, literally rising again from its own ashes, a volcano provides localized benefits that range from electricity in Italy to free steam heat in Japan and Iceland. And to the sometimes deadly lava flows we owe the fertility of some of the world's richest farmlands.

Depending on its viscosity and gas content, lava is subject to several kinds of eruptions, and once ejected it assumes many different characteristics in cooling. Two of its chief forms are known by their exotic Hawaiian names—"aa" for rough, slaglike lava, and "pahoehoe" for

smooth, ropy lava like that shown above. The contribution lava makes to fertility is well known, though scientists are still trying to determine why this is so. It may be the water-holding properties it imparts, rather than the nutrients it contains, that enrich the land. Whatever it is the soil around and over lava seems to become extraordinarily productive when there is also enough rain. Bountiful sugar-cane plantations surround Pelée, and grape vines grow lavishly in the shadow of Vesuvius. After Krakatoa's disastrous explosion and collapse in 1883, all that remained was the crater's low stump covered with thick, vile-smelling ash; yet just three years later grasses were already taking root in the thin beginnings of a new soil, and 10 years later the island was green again, supporting coconut trees and steadily returning to impenetrable jungle. Thus, with a few exceptions, the lava that kills also quickens new life.



A **LAVA MONUMENT** stands surrounded by crumbling clinkers amid the sulphurous crater lake in Narborough Island's main volcano. Behind it at

left is the inner cone. In the distance rise the walls of the outer crater. The island is one of a bleak, inhospitable cluster 650 miles west of Ecuador.

A VOLCANIC WORLD

In 1835 the naturalist Charles Darwin found on the Galápagos Islands, as if in a laboratory model, a striking example of how some of our land was formed. Like all of the islands in the Pacific, the Galápagos were built up from the ocean floor by thousands of lava flows over millions of years. According to Darwin, about 2,000 volcanoes, most of them extinct, stud the barren archipelago; and on Narborough Island, all around the great crater shown at the right,

Darwin observed "immense deluges of black naked lava, which have flowed like pitch over the rim of the cauldron." Inside Narborough's crater is a lake, hot and sulphurous; poking up from the water is a subsidiary cone, composed of volcanic ash, which has a lake of its own (*below*). Volcanic lakes can disappear and reappear unpredictably. In 1957, a Norwegian expedition looked over the crater rim and Narborough's lake was no longer there.



THE INNER CRATER contains its own lake, 500 feet by 300. This lake and the outer one have the same level, an indication of a subterranean duct.

THE MAIN CRATER of the volcano (*right*) rings a lake 11 miles around, framing its inner cone. The outer walls are 4,900 feet above level of the sea.





VOLCANIC RIDGES, SALTY FLATS



AN EXTINCT VOLCANO in Hawaii rears high on the landscape. Its ancient lava weathers to soil that nourishes crops and cows on the farm below.

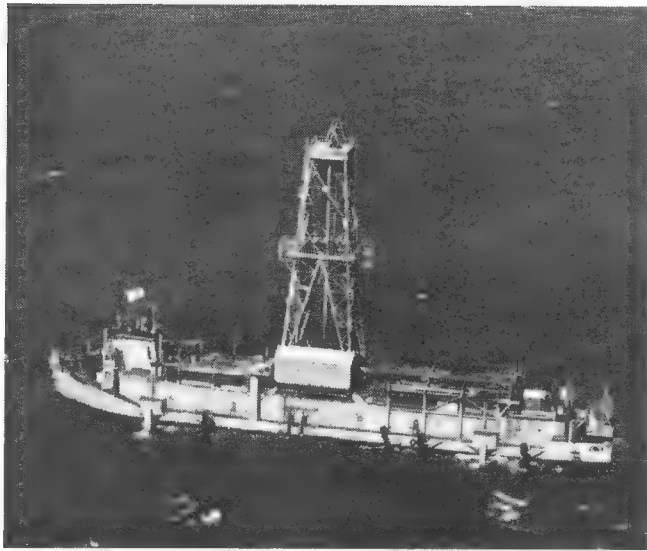


THE SALTY BASIN of a prehistoric lake, the Bonneville Salt Flats stretch at dead level across the northwest corner of Utah. Today an unbroken line of telegraph poles 10 miles long marches in stately order into the horizon, and roaring motorcars set world speed records on this natural race course. Both are possible only because of a series of dramatic changes that have transformed this entire area during the recent geological past. Some 10,000 to 15,000 years ago—during the Pleistocene Era—Lake Bonneville, a vast land-locked body of water, covered more than 20,000 square miles of territory, extending its basin into Utah, Nevada and Idaho. At least three times,

possibly four, the waters of this mammoth lake rose to levels over 1,000 feet deep and fell again, receding finally to the lake we know today as the Great Salt Lake. The present Bonneville Salt Flats and the surrounding Great Salt Lake Desert are the former bottom and shores of the original Lake Bonneville—only one of the 140 fresh-water lakes that existed in the West during the Pleistocene Age. Since that time ground water, seeping up from sediments below the former lake bottom, and rain waters, continuously dissolving salts from rocks, have left evaporated saline deposits estimated at more than a billion tons. Recovering this salt is a major industry today.

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THE CUSS I drills in the deep Pacific during 1961 trials for Project Mohole. Standing amidships is a 98-foot derrick, and on deck are three miles of drill pipe stacked in 60-foot sections.

PROBING THE EARTH

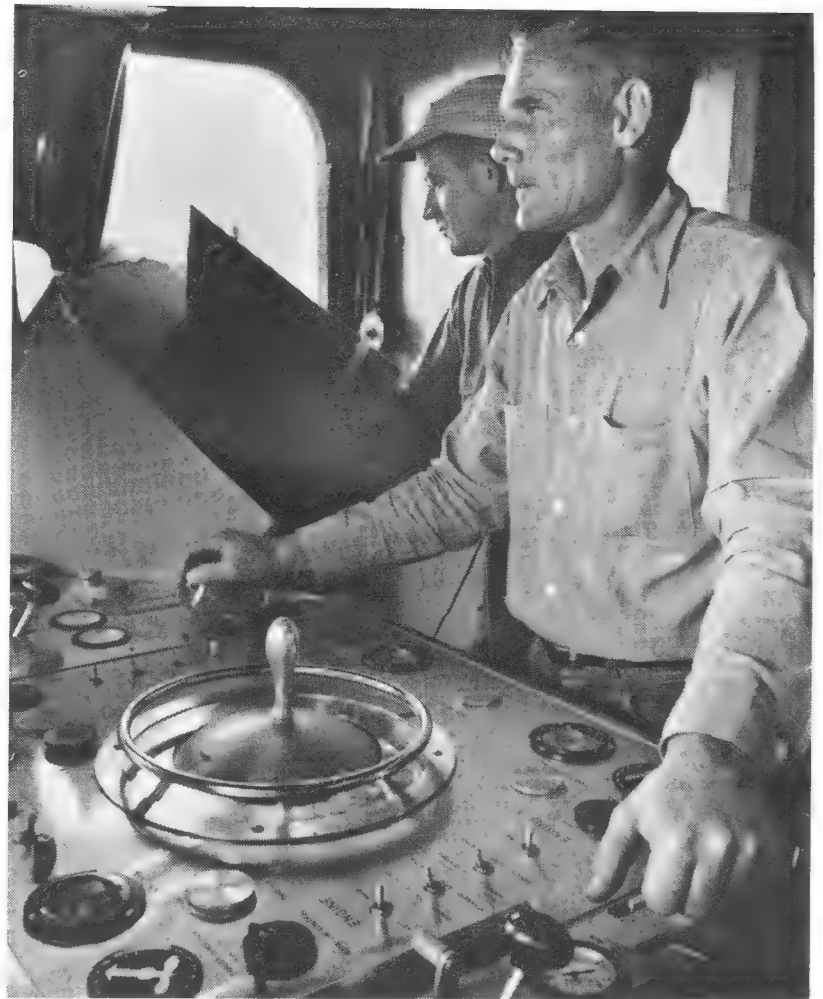
Land is drilled through the sea

While the past few years have vastly extended man's reach into the heavens, his deepest penetration of the earth measures scarcely five miles. But a promising boost for all of the earth sciences began on March 26, 1961, aboard an awkward barge wallowing in Pacific swells about 260 miles south of Los Angeles. The barge was the *Cuss I* (above), and it was testing for Project Mohole, a plan to drill through the earth's crust and obtain the first samples of the underlying mantle.

Why drill at sea? Because the crust's rock is, on the average, more than 20 miles thick on the land but only a few miles thick under the oceans' floor. These conclusions, like most of our ideas about the earth's interior, are heavily based on data compiled at seismological stations around the world. When an earthquake occurs, its vibrations travel swiftly through the body of the earth. By comparing the times these vibrations take to reach various stations seismologists are able to pinpoint the quake. They have also found that the vibrations shift speed at certain precisely defined depths. Such shifts must signify radical changes in the properties of the earth's interior matter, and therefore the boundaries between two distinct zones are known as discontinuities. The crust-mantle boundary, named the Mohorovičić discontinuity after the Yugoslav scientist who discovered it, is called "Moho" for short—hence the name of Project Mohole.

Toward midnight that March 26, *Cuss I* was steadied in position, then its derrick began lowering a diamond-studded drill through two miles of water. For two weeks the scientists worked away, half expecting the drill pipe to bend or break in the swells. But the pipe held. They sank five holes in the ocean floor as deep as 1,035 feet. These test borings proved that the technique was feasible and persuaded the U.S. National Science Foundation to commit up to \$50 million to the three- to seven-year drilling job that Mohole entails. The foundation's director, Dr. Alan T. Waterman, called this "man's greatest single geological project."

En route to the mantle, Mohole scientists will bring up a continuous core sample of sediments and volcanic rocks. Whatever the pierced mantle contains, specimens of it will soon supplant guesswork as to its composition, density, radioactivity and other properties. Even more, they will provide stronger clues to the origins of the earth, and of the earthquakes that still shake the land (*next page*).



AN INTENT PILOT, Ralph McCoy keeps the *Cuss I* steady above its drill hole in the Pacific floor, two miles beneath. To hold the barge in position he had to stay at dead center of a ring of sunken buoys, shown on his sonar screens.



A PRECIOUS CORE, drawn up from hundreds of feet down in the sediment coating the ocean floor, is carefully sliced into sections by a paleontologist so that the fossils imbedded in the mucky sediment can be removed for study.



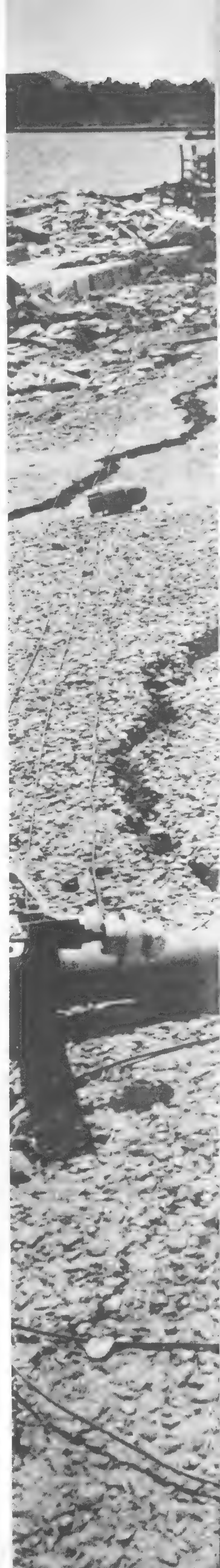
A QUAKE IN JAPAN, shaking the city of Fukui in 1948, topples a department store against a backdrop of raging fires. The Fukui disaster, which took 3,895 lives, was no novelty to the

Japanese. Their islands are subject to quake and volcanic activity as fierce and frequent as anywhere on earth. The tragic Tokyo quake of 1923 killed more than 100,000 people.



A TSUNAMI IN HAWAII floods a road on Oahu in 1957. Inaccurately called "tidal" waves, tsunamis are the result of shock waves caused by the displacement of vast amounts of

water in seaborne earthquakes or volcanic eruptions. This one began in the Aleutian Islands, raced more than 2,000 miles in less than five hours. It hit Hawaii with 32-foot-high waves.





A LANDSLIDE IN U.S., which dumped a house and a stretch of highway into Montana's Hebgen Lake, leaves the road's broken spine on the edge of a precipice. The slide was started by a severe 1959 quake near Yellowstone Park.

THE LAND'S AWESOME ACTION

The land itself can take an active role. Among nature's most awesome events, none is more violent or more dangerous than a major earthquake. Defying prediction, striking with a force that may exceed the explosive power of a billion tons of TNT, it can literally and appreciably move a whole region. Its devastation may be compounded by landslides in the mountains, fires in the cities and huge waves at sea that ravage shores thousands of miles away. In the deadliest earthquake on record, 830,000 people died in Shensi Province, China, in 1556. Twice 20th Century quakes have taken tolls of over 100,000, and in the past few years quakes have killed 12,000 in Morocco and 5,700 in Chile.

For reasons still only partially understood, some 80% of all the world's earthquakes occur along the rim of the Pacific Ocean; another 15% occur in a band that runs from Spain and North Africa, through Italy and Greece to India and Burma, joining the Pacific's "ring of fire" at the Celebes. Most earthquakes, and the severest of them, originate a few miles down in the crust, but a number start in the mantle 43 to 186 miles down, and some as deep as 446 miles. So constant is the earth's unrest that in an average year there are around 20 major quakes and a million minor tremors—at the rate of nearly two every 60 seconds.

CRACKED EARTH IN GREECE attests to a chain of earthquakes which rocked the Ionian islands in 1953. The heavy tremors killed or injured almost 2,000, caused \$100 million in property damage and left 100,000 homeless.

TODAY THE LAND IS SERENE

The epochal birth convulsions of our land have subsided. The lava beds have cooled; the marching seas and grinding glaciers have departed. The volcanic infernos have mostly ceased, leaving the majestic mountains to mark their memory. The struggling green algae and meandering protozoa have evolved into luxurious forests and fully-developed animals, including man. Yet today the land continues its shaping and reshaping, in slow transitions imperceptible to the unscientific eye.

Earthquakes still disrupt this quiet process (*see previous pages*). Weather works its sudden and violent changes, with shattering winds and smashing seas. But for the most part our land today alters its form in slow, seasonal cycles, softly quiescent, gently nourishing and serenely beautiful. In this brief span in the aeons of time, between the cataclysmic eruptions of its birth and the eventual fiery holocaust of its death, the land presents its most benign face, from the rich grasslands and rolling, tree-shaded plains through ever rising foothills to the mighty snowbound peaks that seem to pierce the heavens.





THE MOUNTAINS

*They are the boundaries of nations,
the molders of mankind, and
the most majestic forms on the land*

Mountains—the great masses that stand high against the skies and take up a quarter of all the land—are nature's most spectacular work upon this earth. They are everywhere; parading proudly down the west coast of the Americas; reaching up from islands of Japan and the plains of Africa; tumbling over one another in France, Switzerland, Italy and Austria; pushing up the ice in Greenland and Antarctica. North of India in the Himalayas, mightiest of the mountain chains, is the 26,810-foot peak shown snow-topped and sparkling pure in her clouds on the opposite page. This is Dhaulagiri (meaning "White Mountain" in Sanskrit)—cold, aloof and, as mountain climbers know, deadly dangerous.

Sixth largest of all the world's mountains, Dhaulagiri seems to be serene and eternal but is young and full of vigor. For mountains, like men, are born, grow old and die. First they are pushed, shoved and exploded out of the earth, bringing up great globs of granite. Then rain, snow and wind grind the granite away. Finally the mountain wears down and the granite becomes part of the soil. The Highlands of Scotland are the remnants of a mighty chain of mountains, perhaps 400 million years old, that once circled the North Atlantic. The Appalachians of the United States and the Urals of Russia are middle-aged mountains of some 250 million years. Then come the youngest and biggest, the Rockies, Andes and Himalayas (and among them Dhaulagiri) of some 70 million years, and the Cascades and Alps of 15

million years—mere infants as mountains go.

In such company man has stood tiny and awed. Over large parts of the world mountains have molded his history and his very body. He discovered that the higher he climbed into the mountains the colder it got. Food became very scarce and in the thin air he breathed in painful gasps. Only greater dangers below could persuade a few to brave the perils above; most men turned back and the mountains became the walls of the world. The Mongoloid and Caucasoid races would have evolved much differently if they had not been walled away from one another by the Ural and the Caucasus mountains. Nations rose and fell in battles for the high passes, the doorways through the mountain walls. In the soaring sanctuaries of Tibet and the Andes, mountain cornices that for centuries were safe from invaders, evolution produced a new kind of man—a rugged, barrel-chested figure with a bigger heart, larger lungs and more blood than the men below—a man uniquely adapted for the bleak environment of the mountains.

Scientists have long been fascinated by high mountains. They suspect that the air man breathes, the water he drinks may have come originally from volcanoes and they hope to find in the mountains' structure clues to the earth's creation. Poets and teachers are also drawn to them, for mountains are places of majesty and reverence. Around them linger the words of the Psalmist David: "I will lift up mine eyes unto the hills from whence cometh my help."

Dhaulagiri, called the "peak of storms" by mountaineers, is one of 14 Himalayan peaks above 26,247 feet. It was climbed in 1960.



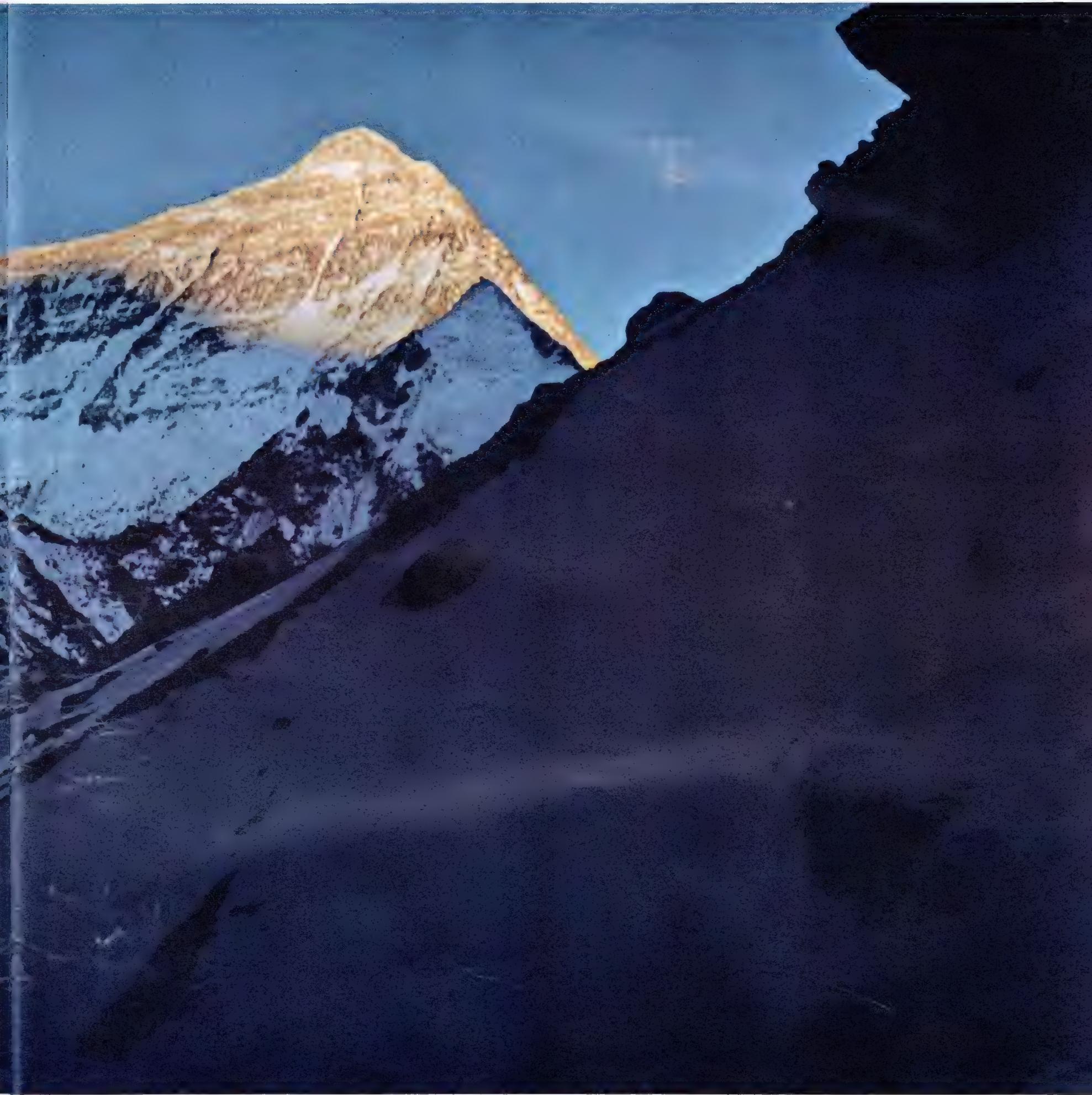
Everest, king of mountains, raises a



Rays from the setting sun make a splendid golden dome of the summit of Mount Everest, monarch of the world's mountains. At 29,141 feet, it is the highest point on earth—although persistent but still unverified sightings of a peak in western China nearly 30,000 feet high were reported by World War II pilots. Everest, named for Sir George Everest, a Surveyor General of the British

Trigonometrical Survey in India, was first discovered in 1852 when one of the company's British clerks found that "Peak XV" on the distant Nepal-Tibet border was actually 1,000 feet higher than nearer and seemingly taller peaks already surveyed. In the early 1920s attempts were made to reach the top of Everest but it was not until 1953, after 30 years of desperate and often tragic

golden peak above the Himalayas



struggle, that the “ferocious malignity” of the brutal mountain was conquered by the New Zealander Edmund Hillary and Sherpa Tenzing Norgay. This remarkable photograph was taken by Norman Hansen, a member of a private, four-man amateur expedition led by Woodrow Wilson Sayre, which made an attempt to climb the north face of Mount Everest on the forbidden side now

occupied by the Chinese Communists (LIFE International, March 25). It was the eighth unsuccessful attempt to climb this side of Everest since a British party first explored the northern approaches to the mountain in 1921 and found a route up the Rongbuk Glacier. It was on this glacier that Mr. Hansen pointed his camera up toward the sun-bathed northern face of Mount Everest’s peak.

Awesome and perilous peaks

The spectacular combination of awesome mountains like the Matterhorn below and fairy-tale villages (*right*) has made Switzerland a mecca for nature-loving tourists. For Alpine dwellers, the combination is a mixed blessing. The impregnable fortress of their snow-capped mountains has enabled the Swiss to enjoy centuries of undisturbed independence and prosperity. But the very mountains whose melting snows and glaciers each year bring fertility to the sheltered valleys also bring death. With the fall of the first snow, terror stalks the land of the peaceful mountain folk. It is the threat of the white death: avalanches. Dropping like solid waves from almost vertical walls, immense cascades of snow, often accompanied by tornadolike winds as high as 70 miles an hour, can obliterate entire villages and take a toll of at least 20 lives a year.



Looking up (*above*), villagers of Zermatt can admire the 14,780-foot Matterhorn rising like a pillar into the sky. First climbed in 1865, it is the Alps' fifth highest.

Looking down on the village of Lauterbrunnen, the upland farmers in hillside chalets are treated to a vista of green carpets rising toward the 13,668-foot Jungfrau.







Challenge to cars and men

Switzerland has long since learned to live with her mountains. Her various valleys and cantons, once isolated from one another, are now linked by roads, funiculars, cable cars, bridges and tunnels. Electric trains whisk into tunnels, out over bridges and back into tunnels following a route that reaches every corner of the country. But travel can still be difficult.

Strung along the mountainsides are zigzag roads such as the one at left working its way up the St. Gotthard Pass toward Italy. Until recently this was the principal motor route between Switzerland and Italy. Crossing it calls forth the last ounces of strength in a motor. In the winter the pass, first used as a mule path in the late 13th Century, may be blocked temporarily by sudden avalanches.

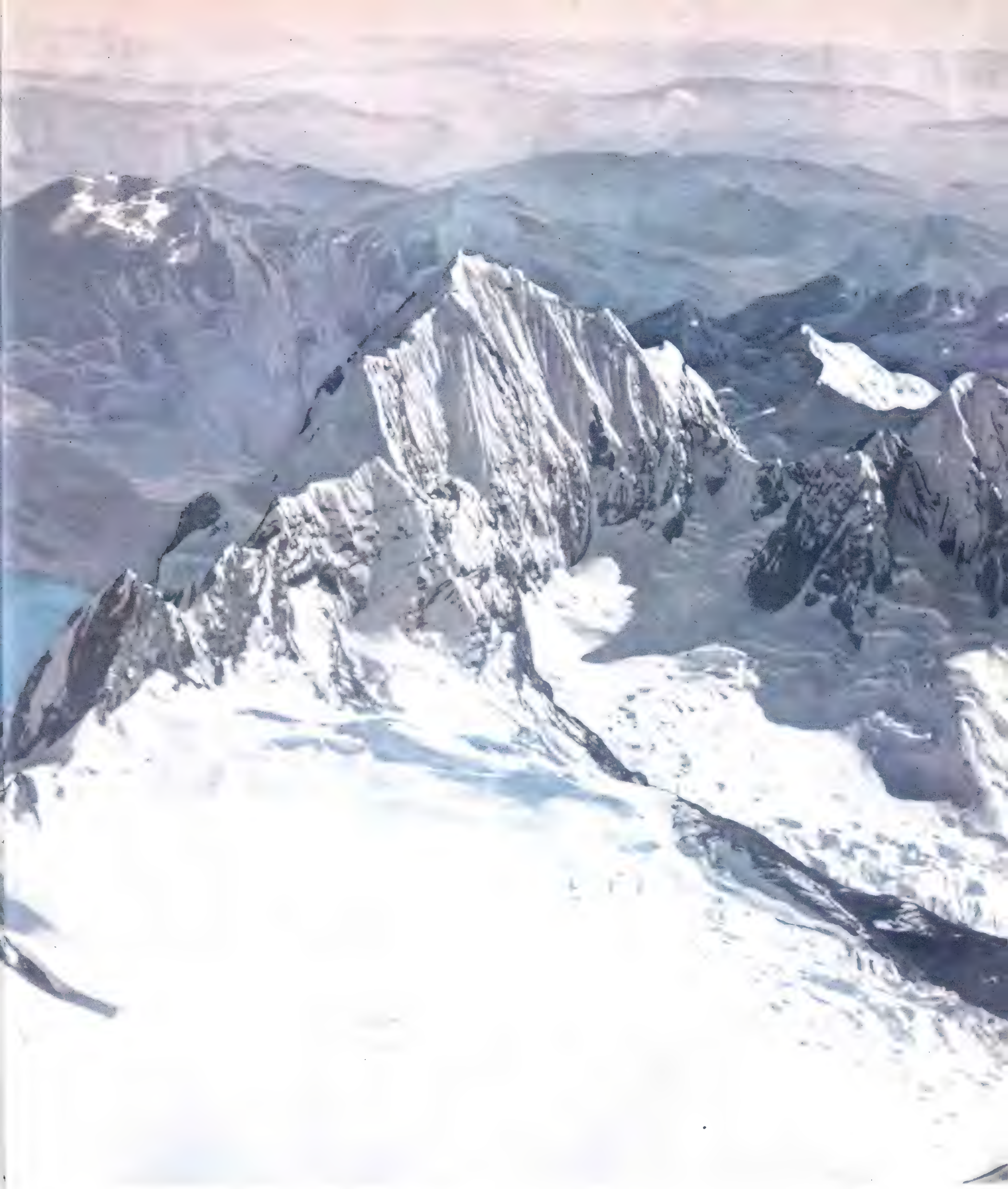
The same challenge which the Alps present to cars also appeals to humans. The young man shown atop a soaring needle rock 7,000 feet up in the Alps took on one of the climber's greatest tests of skill and nerve: the Needles of Chamonix—a spine-chilling forest of granite spires that stand sentinel on the east and northern sides of Mont Blanc where Alpine France and Switzerland meet. Though Mont Blanc was climbed in 1786 by a chamois hunter and a local doctor, the highest of the steely Needles of Aiguilles—Aiguille Verte (13,520 ft.)—was not conquered until 1865. Since then they have had an irresistible attraction for rock-climbers the world over.





Curving down from the Caribbean Sea to the southern tip of Chile, the jagged Andes stretch 3,500 miles along the west coast of South America. An unbroken line of mountains—the longest in the world—they dominate the geography of the entire continent, trapping rainfall for the great rivers of Brazil and Argentina, shutting it off from the Atacama Desert of Chile.

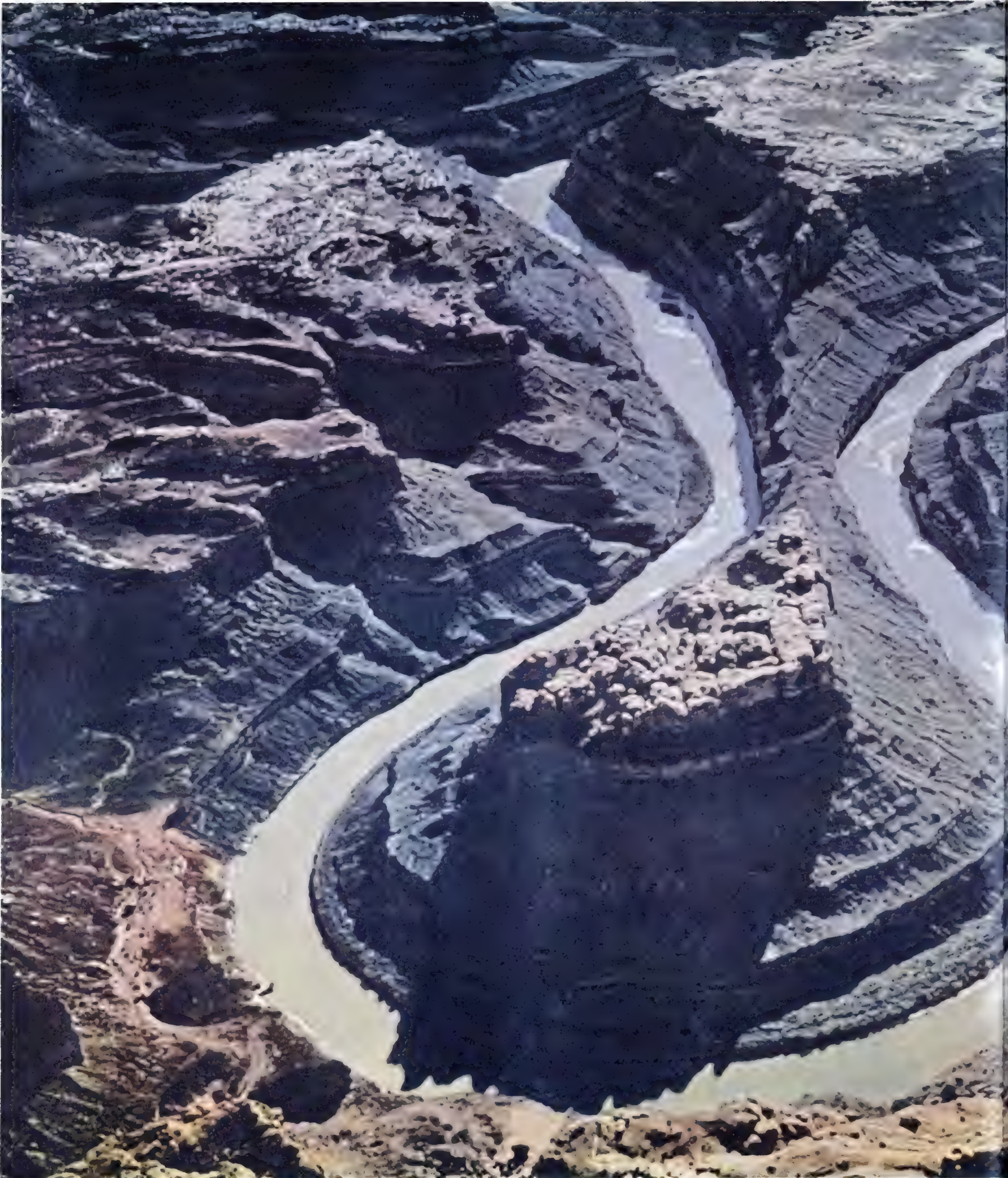
Between the peaks, some of which tower 21,000 feet, deep valleys plunge downward. Here and there living volcanoes smolder and glaciers and green jungles gleam within a few miles of each other. Brilliant contrasts make the Andes the world's most beautiful mountain range. Sunrise comes unevenly, illuminating the white spines of major peaks while valleys are still pitch black.



Sharp variations in altitude and rainfall, making unexpected neighbors of verdure and aridity, stage-manage startling changes in color. At about 16,000 feet, the snow belt begins: the peaks above are forever blue-white. As the Andes sweep south into Peru, they form closely parallel ranges (*above*). The 18,000- to 21,000-foot Cordillera Blanca (White Range) in the foreground

never loses its heavy mantle of snow, but the nearby Cordillera Negra (Black Range) is slightly lower and thus bare in summer except for a drab cloak of alpine vegetation. Between these ranges lies the well-populated Huaylas Valley, a rich tropical outpost isolated by some of the world's most formidable mountains, many of whose towering peaks are still nameless and unknown.

Water vs. the land: A mighty river



Mountainous shapes and forms can be created by the very processes of erosion that elsewhere smooth mighty massifs down to little hills. The Colorado River, shown above corkscrewing through one of its

many spectacular canyons (this one in Utah), carries away annually some 500,000 tons of earth, rock and sand. This steady erosion has uncovered layer upon layer of deposit that reveals the land's history

carves out great canyons



to the geologist's eye. For the first 600 million years a warm and shallow sea covered the land, retreating and returning, until it had left many layers of sand and mud that hardened into a bed of rock 12,000

feet thick. Then, 10 million years or so ago, a mighty and unknown force lifted the entire area thousands of feet above the sea and tilted it so that flowing water began cutting out these magnificent canyons.



Sheets of storm ice jut toward a summit in the Ruwenzori range, the fabulous Mountains of the Moon that tower above Africa's steaming jungles.

An Aracuaria grove marches up an Andean slope. These flat-topped, 100-foot-tall trees are found primarily in the Andes of South America.

A HARD LIFE FOR FLORA

Plants adapt to the rigors of high altitudes

Most plants find mountains inhospitable. The temperature falls from three to five degrees with each 1,000 feet of altitude. Winds pick up force. Oxygen grows thin. It rains too much or too little. But there is no uniformity in the coldness or in the kind of weather that may swirl about even the highest mountain peaks. Tropical mountains like those shown on these pages escape the cyclonic storms and attendant drastic weather changes of the

temperate and polar regions. As a result, they support vegetation markedly unlike that found on mountains in colder zones. However much they differ individually, all mountains have climates different from those of their surrounding lowlands. And each is banded with horizontal layers of different kinds of trees and shrubs. The higher the zones, the harsher life is for plants until, in the fields of perpetual snow, botany finally bows out completely.







The vivid blooms of the slopes

On no mountains is the stratification of life more extreme than on the Ruwenzori, a mist-shrouded range 80 miles long in equatorial Africa where, within a few miles, jungle heat gives way to glacial cold. A bizarre museum of living things is crowded into five bands of habitation. Up to 350 days a year, a drizzling rain feeds the growth of Ruwenzori's giant foliage like that on its cold, dripping heath (*left*). But in the higher regions of the polar and temperate zones, where plants must deal with a formidable quintet of short summer, cold, ferocious winds, unstable soil and too much or too little water, the plant life is small and humble rather than lush and exotic. Plants in the colder zones tend to grow slowly, taking advantage of brief warm seasons and hibernating when extreme cold takes over. Some hoard their energy several years before blooming. They grow low, out of the way of high winds. Scientists call them "belly plants" because, as with the examples shown below, a person must lie on his stomach to get a good look at them.



The brilliant-colored foliage of the purple gentian is a characteristic many plants develop on the high slopes. Some scientists think their deep hue may be a response to excessive amounts of ultraviolet radiation.



Small and short-stemmed, the cushion plant hugs the ground like a wee dome. Its shape, an adaptation to counter wind and cold, permits it to grow the dense blossoms and three-foot taproots vital to its survival.

At 12,000 feet the Ruwenzori's heath, just below the Alpine zone, is a cold morass strewn with fallen trees and carpeted with moss. Heather and lobelia spikes loom in the fog that blots out most of the sun.



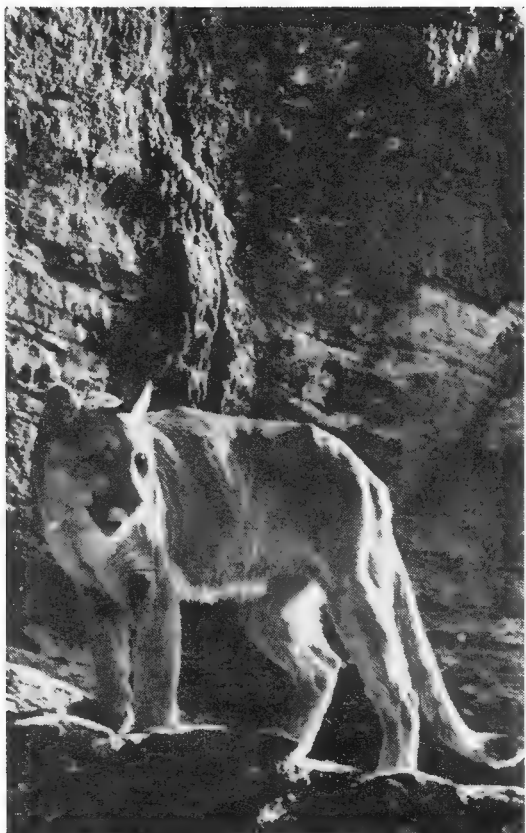
High on an Andean ridge, where he lives far from all lowland enemies, an alert guanaco keeps a sharp eye out for his worst enemy, the mountain lion.



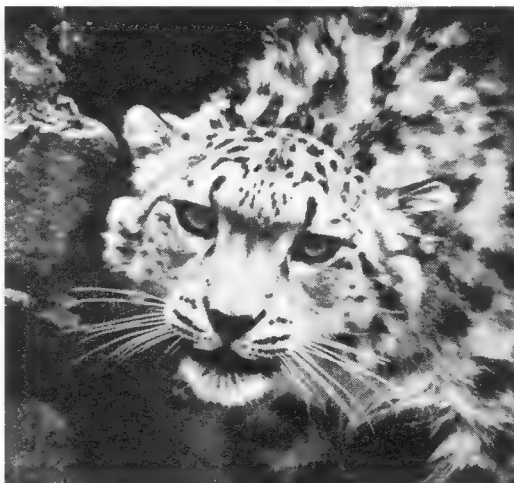
A golden eagle, North America's largest preying bird, totes a ground squirrel to its lair. Birds endure altitude changes better than men because of more efficient lungs.

Fugitives from the Plains

The bare ridges and ravines of mountain terrain above the timber line may appear desolate, but they abound with an astonishing variety of animals and birds. Unlike alpine plants which must grow wherever their seeds land and germinate, animals do have some choice of habitat. Why then do so many persist in living in one of the most difficult environments in the world? Most are fugitives from the plains, forced to flee upward by competition for food with other animals. They simply took to the hills where they became, like plants and man, adapted to the rigors of high-altitude living.



The mountain lion (also called puma, panther, cougar and catamount) is seen nearly everywhere in the New World, from Alaska to Argentina. A legendary marauder, it even attacks livestock.



The long-haired snow leopard is not a leopard but probably the largest spotted cat in the world. It prowls the mountains of central Asia, rarely comes below 6,000 feet even in the coldest winters.



An agile Rocky Mountain goat grips a slope with its specially adapted hoofs. Not a true goat, it spends its life above the timber line, making the most of sparse forage with four stomachs.



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Man at High Altitudes

The association of men and mountains is almost as old as that of men and the cradling sea, even though the terms of life are different in the mountains, and usually harder for man. Basically, they are set by three controlling influences and the ways in which these combine: the terrain of the mountains, the climate, and the isolation from the rest of mankind that mountain living enforces.

Of these, terrain is most important. Even in the most favored climates, the mountains put forward constraints that weigh upon life. These may be overcome, but the price is high. The tilt of the land makes everything more laborious. Extra energy must be expended not only to drag burdens uphill but also to brake their descent. Every hillside field requires more work. The slope, moreover, is not simply a passive foe. It is continually dragging the very earth of man's fields downhill.

In many places around the world, men try to fight the slope with retaining walls and terraces. But terraced fields take a big effort to build and unremitting work to maintain. In the Philippines, in India and Nepal, in the densely settled valleys of southeast Asia, above all in the collectivized countryside of China, millions of people struggle throughout their lives to keep these layered fields in place. Even along the relatively gentle "Golden Slope" of the Burgundy wine country in France, the vinegrower rushes out after a rain to put back the washed-out soil with his bare hands. The slope of the terrain, then, is a force so unfriendly that the only man on the mountain who seems to profit from it is the skier.

The influence of the climate, the second fundamental factor, is somewhat more complex. In the Temperate Zones, mountain weather discourages man from making a living, blanketing the fields in white for much of the year, shortening the growing season to a bare two or three months. In the highest places of the world's temperate belts, it is simply too cold for man to live permanently. Yet in the tropics, mountains may be man's best habitat. They are free of malaria, sleeping sickness and other hot-country diseases; they have the milder temperatures and more equitable rainfall; they may even have the better soil.

The valley of Mexico, an "intermontane basin" 7,500 feet up



Mountains have always filled men with a sense of the divine. The Japanese revere Fujiyama (*above*), make pilgrimages to its peak.

in the continental backbone and site of the country's capital, has been a center of political power through 3,000 years of Middle American civilization. Scholars believe that the domestication of corn, which gave rise to the first civilization of the New World, was achieved somewhere in the highlands of Guatemala or southeastern Mexico. Bogotá in the Colombian Andes is situated almost directly on the equator, and yet its altitude of 8,659 feet gives the city such a cool climate that woolen clothing must be worn during most of the year round.

In many upland spots near the equator, there are no such changes of season as most of us are used to. In certain regions of the Bolivian and Peruvian Andes the climate is perpetual springtime, peach trees bloom all year long and fields yield several crops annually. In fact, the environment in these areas is agreeable enough to have fostered the development of the continent's last great native civilization, that of the Incas. In the course of Andean civilization's 4,000-year development, millions of people occupied the high valleys of the central Andes, and many of them established themselves long ago in some of the highest permanent habitations on

earth. At the extreme heights, however, the numerous advantages of high-altitude equatorial living disappear altogether; the air gets too thin and too cold to be called friendly. For the ordinary run of mankind, in fact, the climate in the high Andes is so unfavorable to man that it poses what seems to be an almost unsolvable problem in survival: how can man get enough oxygen out of the thin air?

Most of us live near the very bottom of a 10-mile-deep ocean of air. This air, having weight and being compressible, becomes denser as it gets deeper. At sea level a man is adapted to this density, or "pressure," which is 15 pounds per square inch, and his lungs are so constructed that when he breathes in a gulp of air the 15-pound pressure will force a sufficient supply of oxygen through the thin linings of his lungs to give his blood what it needs. But as one goes higher the pressure is reduced. At 10,000 feet it is down to only 10 pounds, which is not quite enough to push an adequate supply of oxygen through the linings of the lungs. As a result the blood may carry as much as 15% less than its normal load of oxygen, and the lack may cause headaches, fatigue and shortness of breath. At 18,000 feet the air pressure is only half what it is at sea level, and few people will escape more pronounced symptoms. Unless the human body can somehow overcome the shortage and keep its vital oxygen balance, it will sicken and die.

Yet in the high Andes and in Tibet, people not only survive at

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Andean Indians like the lead miner above have developed a unique physical adaptation to the heights. But they also chew coca leaves to dull their senses.

MAN CONTINUED

such heights but live their whole lives there, working and playing as normally as the rest of us do at sea level. By a dramatic adaptation they have become physically different from the rest of us, mainly by changes in their respiratory and blood-circulating systems. One of the first things a visitor to the high Andes notices is that the stocky inhabitants of these mountain slopes have tremendous, barrel-shaped chests. And they have lungs to match. Furthermore the small pockets, or alveoli, which line the lungs and give added lung capacity are, in these people, always dilated. This lets the greatest possible amount of blood flow through the delicate lung tissues and thus pick up all possible oxygen that is breathed in.

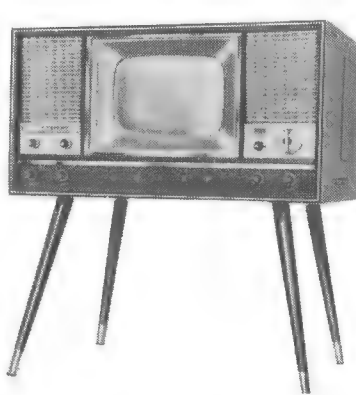
The Indian of the high Andes has about 20% more blood than a lowlander. This extra blood is made up largely of red corpuscles, because it is red corpuscles that hold the all-important hemoglobin which catches and absorbs oxygen. In Indians living at 15,000 feet, there is an increase of almost 60% by weight of this vital hemoglobin. Each of their red blood cells, moreover, is larger than the cells of lowland people, this larger size giving a greater surface for the absorption of oxygen.

Because the mountain Indian's blood is so rich in red cells, it is thicker and more viscous than that of lowlanders. And since the Andean's heart must pump harder at these heights, it is about a fifth larger. Its beat is also slower. The Andean's body is squat and compact, which means that the blood does not have to be pumped so far each time it circulates. At the end of his broad, stubby extremities are an unusually large number of direct passages between small arteries and small veins. This quickens circulation, and enables the Andean Indian to go about unconcerned with hands and feet uncovered at times when lowlanders would suffer severe frostbite if they tried it. Like birds, these people can walk barefoot in the snow without discomfort.

Llamas and alpacas, as in ancient times, provide these people with the warm clothing needed at such heights. For fuel so far above the tree line, the Indians burn llama dung. The principal food of the high Andes is the potato, which was first domesticated on these slopes. Some local varieties of potato are so hardy that they keep right on growing when their leaves are white with frost.

The Andean Indians belong to the Mongoloid branch of the human race. The only other people of the world who have demonstrated the same remarkable capacity to adapt to high-altitude climate are the people of the high

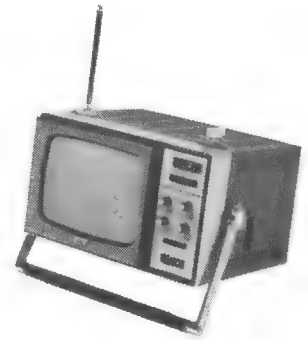
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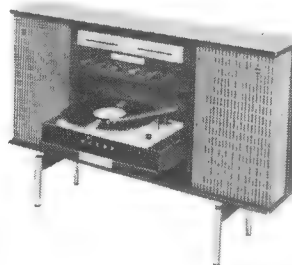
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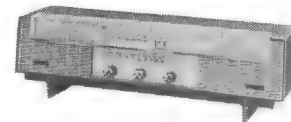
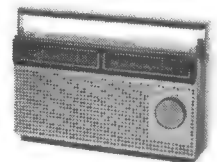
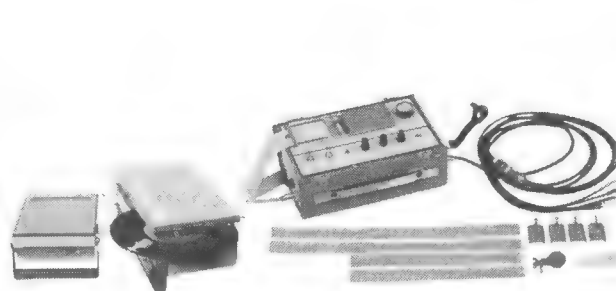


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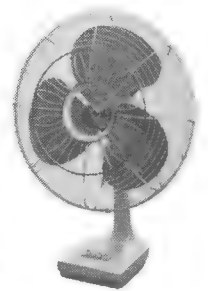


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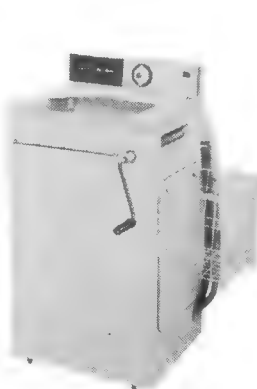


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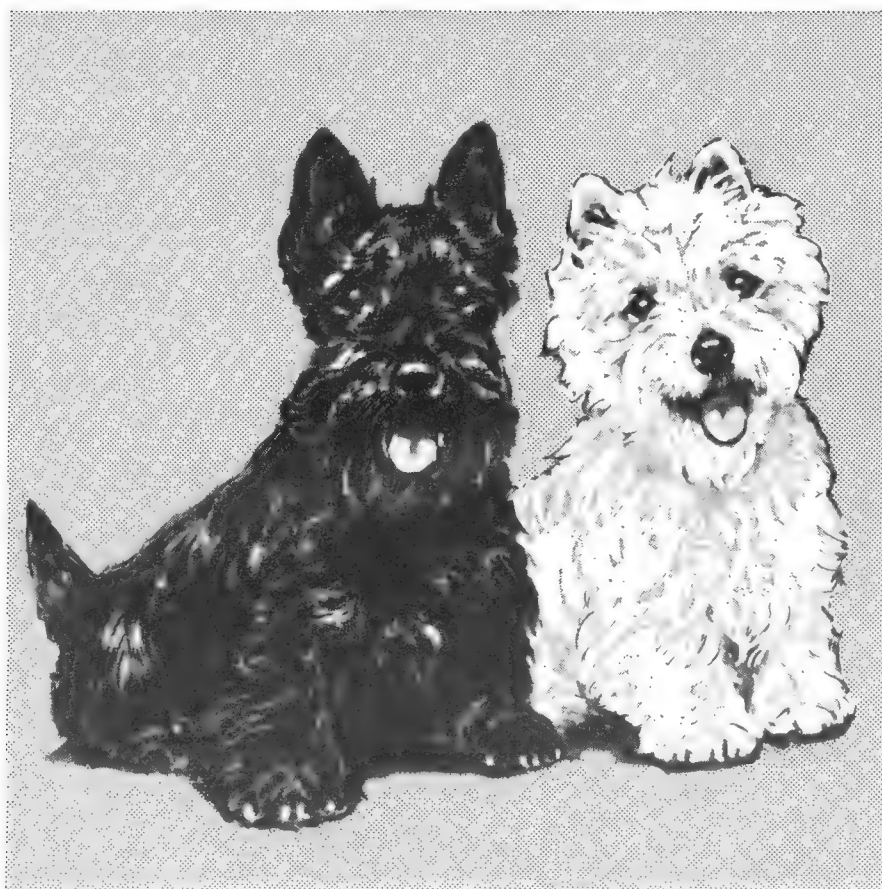
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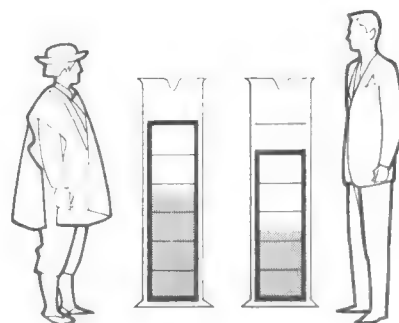
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MAN CONTINUED

Himalayas, and they too are of Mongoloid origin. The Mongoloids are a group whose forerunners emerged during one of the last ice ages in northeast Asia some 360,000 years ago and, in the process of trying to survive amidst high winds and bitter cold, achieved a particularly high degree of cold-resistance. Their very bodies tend to be short and well-rounded, with short extremities that present the least possible surface area for heat loss in proportion to their size. Their noses and foreheads are flattish, their cheeks broad and fat-padded. And from above their eyes, hanging like a storm window before the upper lid when the eye is open, grows an epicanthic fold of fat that helps keep the eye from freezing.

All this made an ideal mask to protect eyes, nose and sinuses against the ice-age weather of the past. As the ice age gave ground, some Mongoloids migrated north and east across the Bering Strait land bridge to become the ancestors of the Andean and other American Indians. Others spread south to the Himalayan snows.



Differences in blood between an Andean mountaineer (left) and a lowlander—both 130 pounds—are shown by heavy lines in the beakers above. The Andean's total blood content is six quarts, of which more than half is red cells. The lowlander has only five quarts and less than half is red cells.

Whether in the Himalayas or the Andes, the Mongoloid peoples obviously have adapted well to mountain living, and this goes far in explaining why they live there now. But it does not explain why they should have settled there in the first place. For an answer to this question we must turn to the third of the basic influ-

ences that have shaped man's life in the mountains—the isolation that goes with mountain living.

It seems evident that early man never took to the higher mountains except as he was driven by necessity, by hunger or by fear. The mountains, viewed from afar, must have seemed the land of impassable terrors, the country of wolves, cold, famine, demons. Yet these very terrors of terrain and climate tend to isolate the mountains from the plains and create there a kind of geographic sanctuary. Tibet is what anthropologists call a refuge. That is to say, it is likely that the ancestors of the present Tibetans went there ages ago not so much because they liked the place but because they hoped to gain a security in the remoteness of its mountain fastnesses that they had not been able to win elsewhere.

This they did. Tibet is a huge, inhospitable plateau about one sixth the size of the continental United States, ringed with high mountains. Its average height is 15,000 feet, and Gartok, 15,200 feet high in the northern part of the country, is credited with being the world's highest center of habitation. Not content with such a protective ring of barriers, Tibetans have guarded their isolation by every conceivable human means until their capital of Lhasa (altitude 11,830 feet) became known as "the forbidden city." They tried to bar all people from the outside world—and until the seizure of Tibet by Communist China in 1951 they succeeded fairly well. They resisted new ideas and new ways. And in what seems to be a trait of high-altitude societies, they built up a theocracy. Tibet's was a kind of Buddhist state in which every third male was a monk and the Dalai Lama, or god-king, was supreme over all things spiritual and temporal. Even their theology was shaped by the mountain climate: the hell of Tibetan Buddhism is a cold place.

The key to life for the people of the high Tibetan plateau is that shaggy, ill-tempered relative of the buffalo called the yak. As an all-purpose, high-altitude friend to man, the yak beats even the llama. One does not milk a llama. But the yak furnishes meat, wool, milk, butter, transport.

CONTINUED

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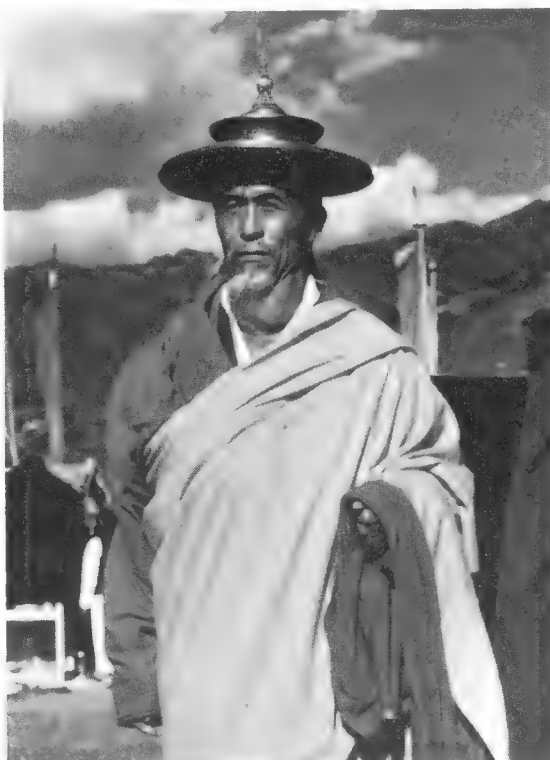
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MAN CONTINUED

The Tibetans and other peoples of the high Himalayas are not the only ones to have found advantage in the refuge that mountains afford. Defeated people everywhere have fled before the conquerors of their rich plains and settled in fastnesses where no one would challenge their right to land that is so little favored and so hard to get at. The Atlas Mountains of North Africa are a sanctuary for the Berber tribes who sought shelter there 12 centuries ago from invading Moslem hordes. In the Mediterranean basin, which seems to have experienced a gradual drying-up at the end of the last glacial period, the mountain valleys around the rain-catching peaks may also have been a refuge for man against the natural invader of the lowlands—drought. Lebanon, a high-country Christian bastion at the eastern end of the Mediterranean, appears to have been a mountain sanctuary for its people from both human and natural foes.

Mountains therefore have been good places for nations to get started. The Swiss mountaineers won the first local self-government in modern Europe, when they formed the Swiss Confederation in the high Alps around the St. Gotthard Pass in 1291. The people of Andorra, who live in the Pyrenees between France and Spain, have guarded their own ways and the independence of their tiny republic through centuries, and still get on quite well by smuggling. That is much the story of the world's smallest republic, 1,500-year-old San Marino, perched profitably in the midst of Italy's Apennines. The people who live in the Appalachian Mountains of the southern United States preserve something archaic in their way of life, even an archaic way of speaking.

From all this we can see that the isolation that mountains enforce upon those who live in them is as powerful as either of the other two big factors of mountain geography, terrain and climate. We may sum up these influences in one word: environment. Yet when we see how man in the mountains has matched himself against a thousand different combinations of these three variables, it seems plain that man's own resourceful nature is just as big a part of the mountain story. Man is the most adaptable animal on earth. This capacity to adapt himself enables him to go almost anywhere he wants, and adds the baffling dimension of human motivation to the story of man and his mountains.



Life is easier in the Himalayas than in the Andes but many Himalayans, like the lama above, have large goiters probably caused by iodine deficiency.

The new 8mm Camera for beginners, too.



**DUALMATIC 50
Model 130**

Sekonic offers you the new DUALMATIC 50 Model 130, the first compact flip-over film chamber camera in the world.

ITS FEATURES?

Why load twice to complete a roll?
When it runs 50 feet with a single roll.
And it's so compact and easy to use.
And the price is below the unbelievably low.

The DUALMATIC 50 is the latest creation in mechanical ingenuity for the use of amateur 8mm photographers. No opening the chamber, no switching of spools, no rethreading, no test re-run. Just flip the chamber in only two seconds, and you are ready for another 25 feet. It has an electric eye exposure system and it focusses sharp with a fixed f/1.8 lens from three feet to infinity.



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Who gets the biggest smile?



The practical man in the beautiful Taunus 17M

You can hardly blame the lady hikers. They know the car seats five without getting personal. And cruises somewhere over 130 kmh in quiet safety. And has interior color schemes that make pretty girls look even prettier. Only the driver knows it's also a very inexpensive car to own. But he won't tell. Why spoil first impressions?

TAUNUS 17M "the beautiful way to be practical"



FIRESTONE WINS FOR 40th CONSECUTIVE TIME at Indianapolis 500-Mile Race

Championship safety and stamina of Firestone tires proved again in world-famous race at Indianapolis, Indiana, U.S.A.

In the greatest outdoor testing laboratory in the world, where only the best can survive, Firestone tires again proved their extra stamina and safety by winning the Indianapolis 500-Mile Race for the 40th consecutive time. Roaring down the hot, abrasive straightways at up to 180 miles per hour and sliding through the 900 tire-torturing turns, the new champion flashed across the finish line on Firestones in utmost safety and without tire trouble of any kind.

Race drivers know that their lives depend on the safety of their tires. That's why the winners of the last 40 races bought and used Firestone tires. They would not risk their lives on any other make.

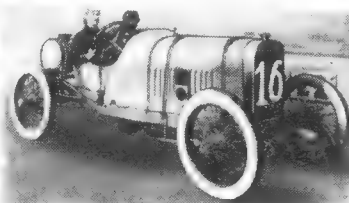
Firestone leads in speedway research. The exclusive Firestone Safety-Fortified cord body, the Safety Tread and now Diene, Firestone's new exclusive synthetic rubber that improves safety and increases tire mileage up to 20% . . . all these major features were first tested and proved on the speedway.

See your Firestone distributor or tire dealer for Firestones—the tires that are Safety-Proved on the Speedway for Your Protection on the Highway.

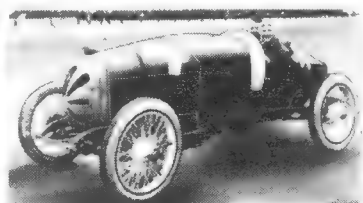
FREE We have an enlargement of the winners of the Indianapolis 500-Mile Race on Firestone tires which we will send you upon request. Write to Firestone International Company, Akron 17, Ohio, U.S.A.



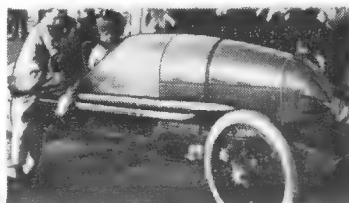
1911 RAY HARROUN
74.59 m.p.h.
120.015 k.p.h.



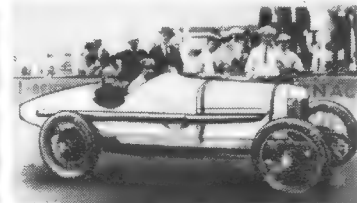
***1913 JULES GOUX**
75.93 m.p.h.
122.171 k.p.h.



***1920 GASTON CHEVROLET**
88.62 m.p.h.
142.589 k.p.h.



1921 TOMMY MILTON
89.62 m.p.h.
144.198 k.p.h.



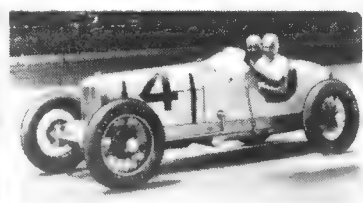
1922 JIMMY MURPHY
94.48 m.p.h.
152.018 k.p.h.



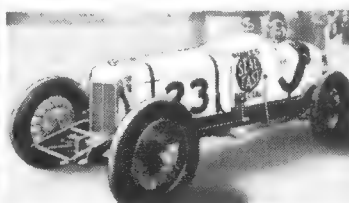
1928 LOUIS MEYER
99.48 m.p.h.
160.063 k.p.h.



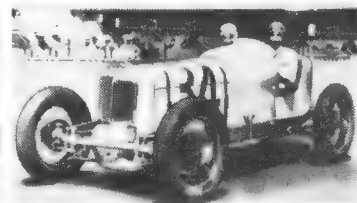
1929 RAY KEECH
97.58 m.p.h.
157.006 k.p.h.



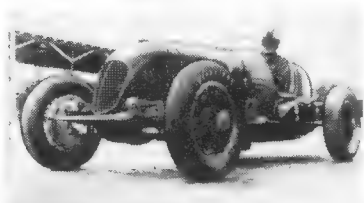
1930 BILLY ARNOLD
100.44 m.p.h.
161.607 k.p.h.



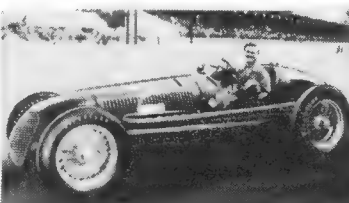
1931 LOUIS SCHNEIDER
96.62 m.p.h.
155.461 k.p.h.



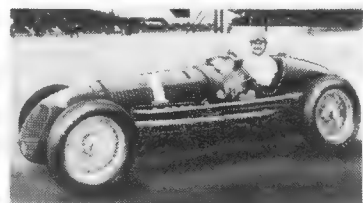
1932 FRED FRAME
104.14 m.p.h.
167.561 k.p.h.



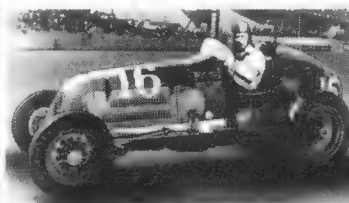
1938 FLOYD ROBERTS
117.20 m.p.h.
188.574 k.p.h.



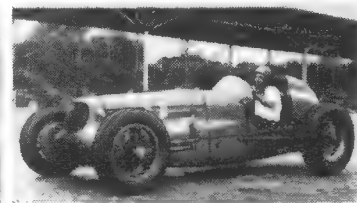
1939 WILBUR SHAW
115.035 m.p.h.
185.091 k.p.h.



1940 WILBUR SHAW
114.277 m.p.h.
183.871 k.p.h.



***1941 MAURI ROSE, FLOYD DAVIS**
115.117 m.p.h.
185.223 k.p.h.



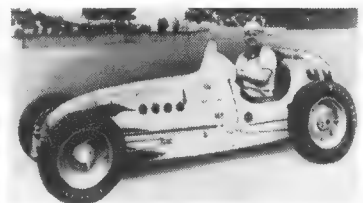
***1946 GEORGE ROBSON**
114.8 m.p.h.
184.713 k.p.h.



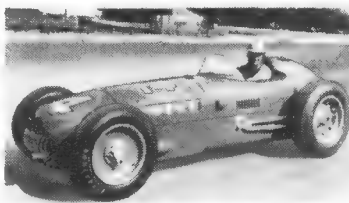
1950 JOHNNY PARSONS
124.002 m.p.h.
199.519 k.p.h.



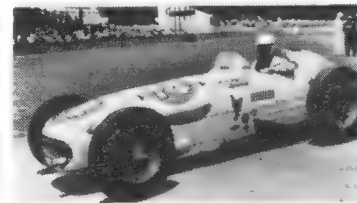
1951 LEE WALLARD
126.244 m.p.h.
203.126 k.p.h.



1952 TROY RUTTMAN
128.922 m.p.h.
207.435 k.p.h.



1953 BILL VUKOVICH
128.74 m.p.h.
207.142 k.p.h.



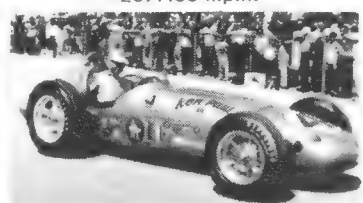
1954 BILL VUKOVICH
130.840 m.p.h.
210.521 k.p.h.



1958 JIMMY BRYAN
133.791 m.p.h.
215.269 k.p.h.



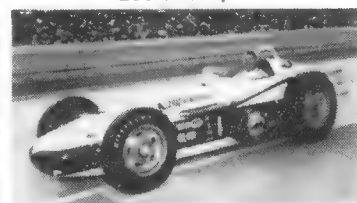
1959 RODGER WARD
135.857 m.p.h.
218.594 k.p.h.



1960 JIM RATHMANN
138.767 m.p.h.
223.276 k.p.h.



1961 A. J. FOYT
139.13 m.p.h.
223.86 k.p.h.

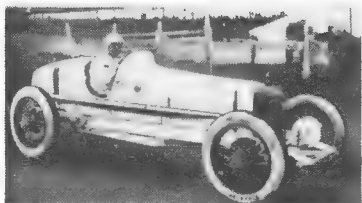


1962 RODGER WARD
140.292 m.p.h.
225.730 k.p.h.

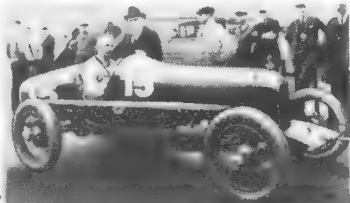
*No races in 1917, 1918, 1942, 1943, 1944, 1945



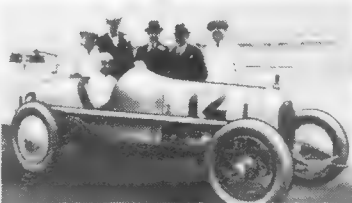
Parnelli Jones, 1963
winner at 143.137 m.p.h.
(230.307 k.p.h.) says:
*"Firestone's record at
Indianapolis tells more
about its tires than
anything I can say.
That's why I bought
Firestones for my car!"*



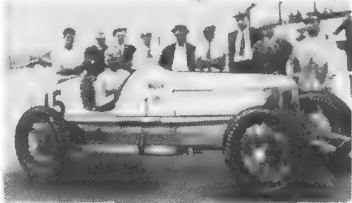
1923 TOMMY MILTON
90.95 m.p.h.
146.338 k.p.h.



1924 L. CORUM, JOE BOYER
98.23 m.p.h.
158.052 k.p.h.



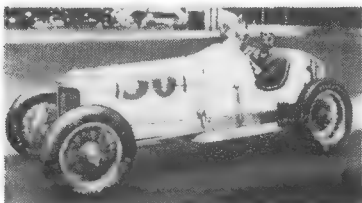
1925 PETE DE PAOLO
101.13 m.p.h.
162.718 k.p.h.



1926 FRANK LOCKHART
95.9 m.p.h.
154.303 k.p.h.



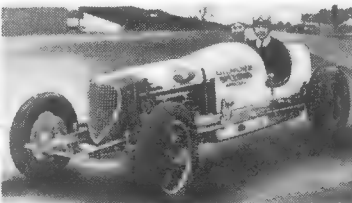
1927 GEORGE SOUDERS
97.54 m.p.h.
156.941 k.p.h.



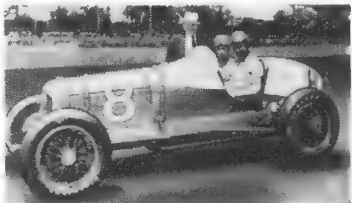
1933 LOUIS MEYER
104.16 m.p.h.
167.593 k.p.h.



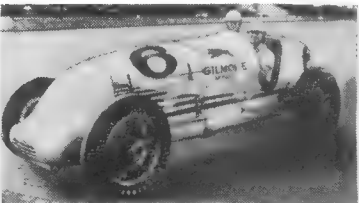
1934 BILL CUMMINGS
104.86 m.p.h.
168.719 k.p.h.



1935 KELLY PETILLO
106.24 m.p.h.
170.940 k.p.h.



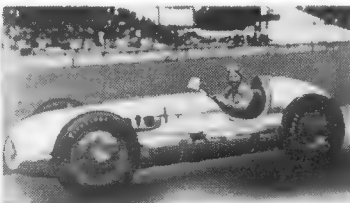
1936 LOUIS MEYER
109.06 m.p.h.
175.477 k.p.h.



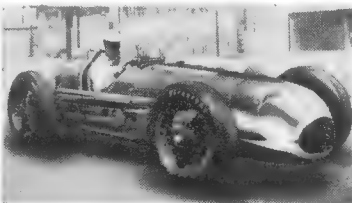
1937 WILBUR SHAW
113.58 m.p.h.
182.750 k.p.h.



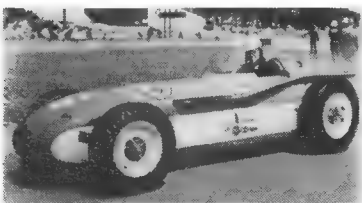
1947 MAURI ROSE
116.33 m.p.h.
187.174 k.p.h.



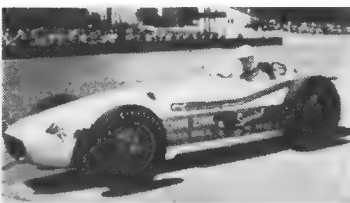
1948 MAURI ROSE
119.813 m.p.h.
192.779 k.p.h.



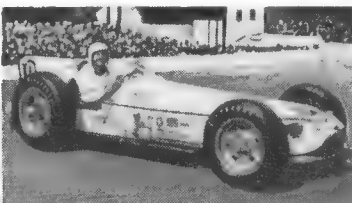
1949 BILL HOLLAND
121.327 m.p.h.
195.215 k.p.h.



1955 BOB SWEIKERT
128.209 m.p.h.
206.288 k.p.h.



1956 PAT FLAHERTY
128.49 m.p.h.
206.740 k.p.h.



1957 SAM HANKS
135.601 m.p.h.
218.182 k.p.h.



Firestone

YOUR SYMBOL OF QUALITY AND SERVICE

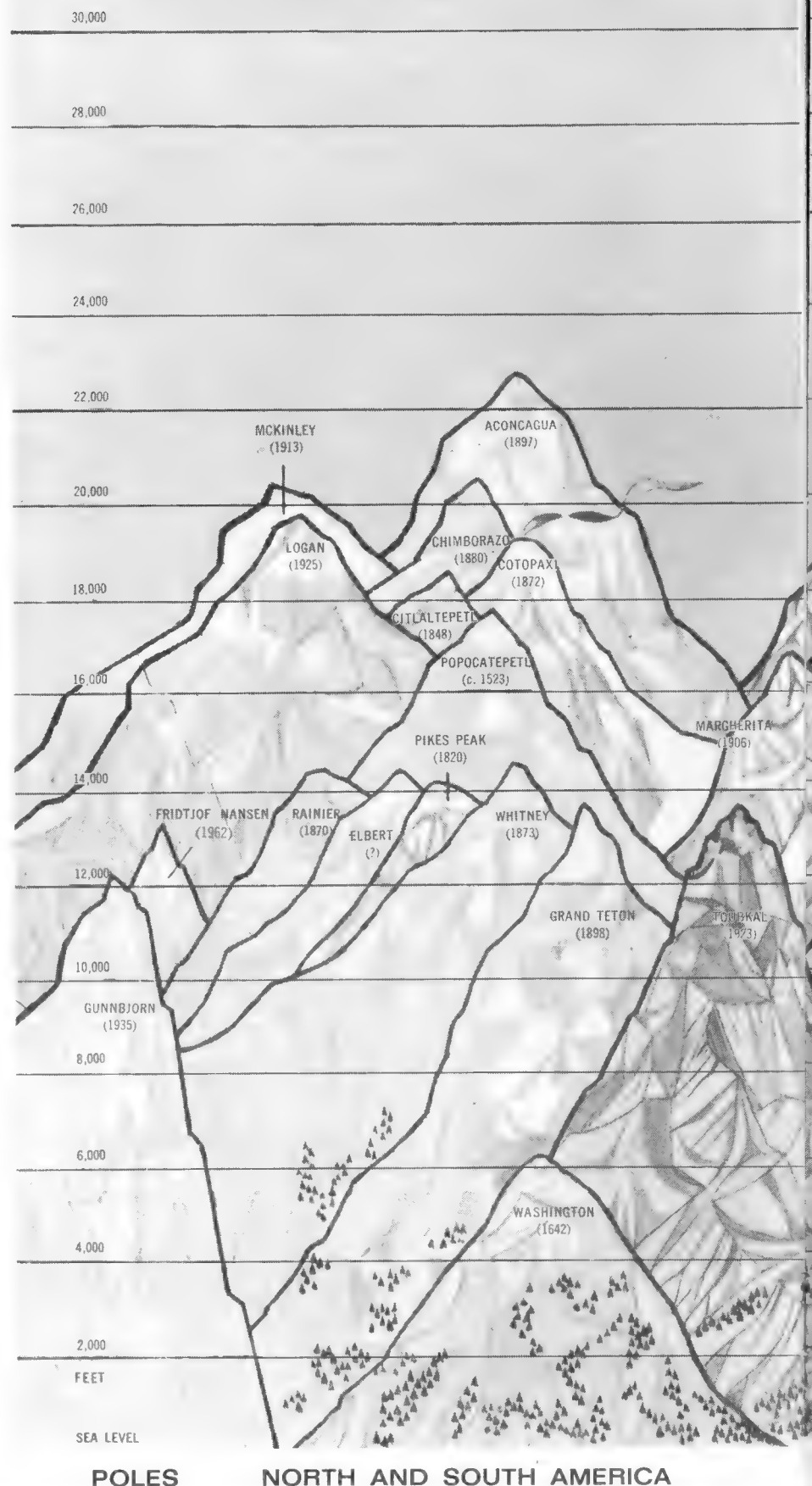
The Elite of the Peaks

The awesome mountain range at right includes the major peaks of the world. In this fanciful drawing are grouped 50 of the mountains which are most famous for their height, their impact on human affairs, or the almost insuperable obstacles they have presented for the mountaineers of history. They are grouped according to the regions in which they are located and the dates in parentheses under their names record the earliest known ascent (question marks indicate that the date of the first ascent is doubtful). The altitudes of these peaks, the nationalities of the mountaineers who first climbed them and other historical details are recorded in the list below.

It is only in the past dozen years, because of new climbing techniques and equipment, that 11 of the world's greatest peaks, including Everest, have been conquered by determined mountain climbers. Less than 500 years ago mountains were regarded as the abode of demons and dragons, and were skirted or traversed at great peril by natural passes; they were rarely climbed. The first authenticated record of man climbing a mountain just for the thrill of getting to the top was in 1492; the mountain was 6,880-foot Mont Aiguille, in the Dauphiné Alps near Grenoble. The next significant milestone in mountaineering did not come until almost 300 years later, in 1786, when Mont Blanc was conquered. In 1854, the particularly difficult Wetterhorn was mastered and the Golden Age of mountaineering had begun.

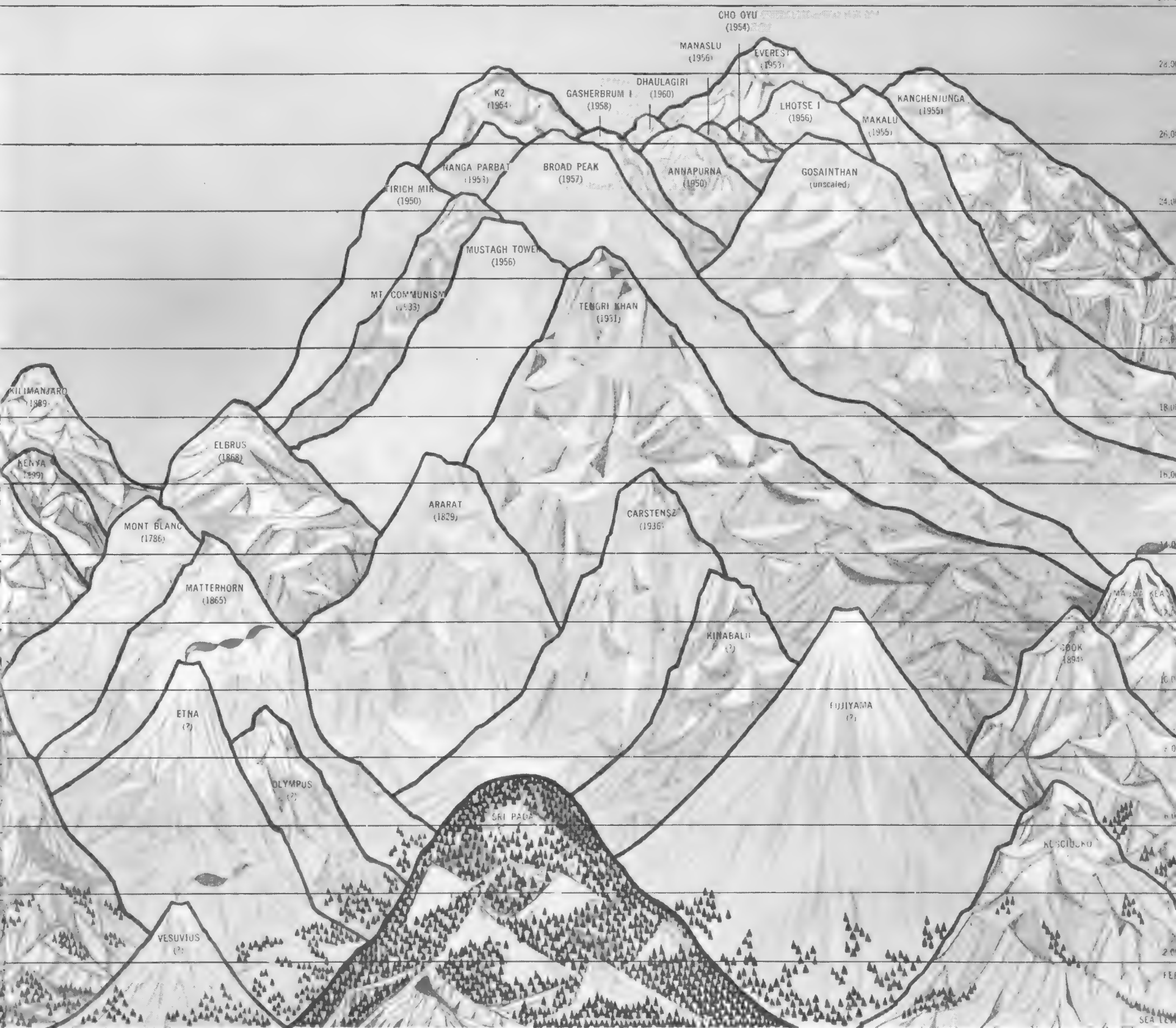
During the next 16 years every major peak in Europe was climbed, culminating in the tragic ascent of the "invincible" Matterhorn in 1865, during which expedition four men plunged to their deaths. After 1870, climbers began attacking the same Alpine summits by more dangerous routes and looking for more spectacular peaks in other parts of the world. Around the turn of the century one great mountain after another was vanquished, including the Andes' Aconcagua, Mount Kenya in East Africa and the fabled Ruwenzori in the Congo. In the 1920s attention turned to the mightiest peaks of all, the Himalayas. Jongsong Peak was surmounted in 1930, Kamet in 1931 and Nanda Devi in 1936. In 1950, after 22 previous attempts, Annapurna became the first "eight thousand" (8,002 meters, 26,247 feet) to be scaled. And finally Everest, monarch of mountains, yielded in 1953. Since then Nanga Parbat, K2, Kanchenjunga and Lhotse, Everest's sister peaks, have also been climbed, and both Swiss and American teams have followed the British example on Mt. Everest (a Red Chinese claim is doubted by most mountaineers).

Today there are few mountains left in the world still unclimbed. Yet man will continue, no doubt to the end of time, to endure indescribable hardship and to risk his life for that elemental thrill of looking out across the land from the very highest vantage point he can find.



PEAK AND LOCATION	ALTITUDE	FACTS AND FIGURES
POLAR REGIONS		
Gunnbjörn, Greenland.....	12,139	Highest Arctic peak. First ascent 1935 (British)
Fridtjof Nansen, Antarctica.....	13,156	Discovered by Roald Amundsen 1911. Scaled 1962 (New Zealanders)
NORTH AMERICA		
McKinley, Alaska.....	20,320	Highest on continent, base-to-peak rise 18,500. First ascent 1913 (U. S.)
Logan, Canada.....	19,850	Second highest on continent. First ascent 1925 (joint Canadian-U. S. party)
Citlaltépetl (Orizaba), Mexico.....	18,696	Snow-covered volcanic peak. First ascent 1848 (French)
Popocatepetl, Mexico.....	17,887	Sacred Aztec peak profaned by conquistadors who climbed it in search of sulphur for gunpowder
Blackburn, Alaska.....	16,523	First major North American climb led by a woman (Dora Keen, U. S., 1912)
Whitney, California.....	14,495	Until Alaskan statehood, highest in U. S. First ascent 1873 (U. S.)
Elbert, Colorado.....	14,431	First ascent claimed in 1847 (U. S.), but previously climbed by trappers and Indians
Rainier, Washington.....	14,410	Volcanic peak bearing 26 glaciers. First ascent 1870 (U. S.)
Pikes Peak, Colorado.....	14,110	First recorded ascent 1820 (U. S.). Now has auto road to summit
Grand Teton, Wyoming.....	13,766	From 1810 to 1840 habitat of trappers and "mountain men." First ascent 1898 (U. S.)
Washington, New Hampshire.....	6,288	First peak in U. S. scaled by a white man (Darby Field, New Hampshire, 1642)
Pelée, Martinique.....	5,243	Wiped out entire city of St. Pierre (30,000 killed) in 1902 eruption
SOUTH AMERICA		
Aconcagua, Argentina.....	22,834	World's longest drop, over nine miles from summit to ocean bottom (Peru-Chile Trench) 100 miles away. First ascent 1897 (British)
Huascarán, Peru.....	22,205	First major peak climbed by a woman (Annie S. Peck, U. S., 1908)

PEAK AND LOCATION	ALTITUDE
Chimborazo, Ecuador.....	20,577
Cotopaxi, Ecuador.....	19,344
EUROPE	
Elbrus, U.S.S.R.....	18,468
Mont Blanc, France.....	15,781
Matterhorn, Switzerland.....	14,780
Wetterhorn, Switzerland.....	12,166
Etna, Italy.....	10,868
Olympus, Greece.....	9,550
Vesuvius, Italy.....	3,842
AFRICA	
Kilimanjaro, Tanganyika.....	19,590
Kenya, Kenya.....	17,040
Margherita, The Congo.....	16,821
Toubkal, Morocco.....	13,661
ASIA	
Everest, Nepal.....	29,141
K2 (Godwin Austen), Kashmir.....	28,250
Kanchenjunga, Sikkim.....	28,168
Lhotse, Nepal.....	27,890
Makalu, Nepal.....	27,790
Cho Oyu, Nepal.....	26,890



AFRICA

EUROPE

ASIA

AUSTRALIA AND OCEANIA

FACTS AND FIGURES
Attempted 1802 by German explorer Humboldt, scaled 1880 by Whymper (British) Active volcano. Attempted 1802 by Humboldt. First ascent 1872 (German)
Highest on continent. First ascent 1868 (British) Highest in the Alps. First ascent 1786 (French) Resisted many assaults, finally scaled by Whymper in 1865 Climbed by British in 1854, marks start of "golden age" of mountaineering (there is earlier claim—1845 by T. S. Spear) Highest active volcano in Europe; more than 260 recorded eruptions in 2,500 years Abode of the gods of Greek mythology Only active volcano on European mainland. Destroyed Pompeii in A.D. 79
Extinct volcano. First ascent 1889 (German) Extinct volcanic cone, almost directly on equator. First ascent 1899 (British) Highest peak of the Ruwenzori. First ascent 1906 (Italian) Highest in North Africa. First ascent 1923 (French)
Highest in the world. First ascent 1953 (British-Sherpa party) Second highest in the world. First ascent 1954 (Italian) First ascent 1955 (British) First ascent 1956 (Swiss) First ascent 1955 (French) First ascent 1954 (Austrian). All-woman attempt in 1959 ended in death of four

PEAK AND LOCATION	ALTITUDE
Dhaulagiri, Nepal	26,810
Nanga Parbat, Jammu-Kashmir	26,660
Manaslu, Nepal	26,657
Annapurna, Nepal	26,502
Gasherbrum, Jammu-Kashmir	26,470
Broad Peak, Jammu-Kashmir	26,414
Gosainthan, Tibet	26,291
Tirich Mir, Pakistan	25,426
Mt. Communism, U.S.S.R.	24,590
Mustagh Tower, Jammu-Kashmir	23,860
Tengri Khan, U.S.S.R.-China	22,940
Ararat, Turkey	16,946
Carstensz, West Irian (Netherlands New Guinea before May 1)	16,503
Kinabalu, Borneo	13,455
Fujiyama, Japan	12,389
Sri Pada (Adam's Peak), Ceylon	7,360
AUSTRALIA AND OCEANIA	
Mauna Kea, Hawaii	13,796
Cook, New Zealand	12,349
Kosciusko, Australia	7,328

FACTS AND FIGURES
First ascent 1960 (Swiss). Two died in previous attempts First ascent 1953 (German-Austrian team). In previous attempts, 29 were killed First ascent 1956 (Japanese). Buddhist leader considered ascent a pilgrimage First "eight-thousander" conquered; scaled 1950 (French) First ascent 1958 (U. S.) First ascent 1957 (Austrian) Unscaled; lies in a little-known section of Nepal-Tibet Himalayan range Highest in the Hindu Kush. First ascent 1950 (Norwegian) Formerly called Stalin Peak. First ascent 1933 (Soviet) First ascent 1956 (British) First ascent 1931 (Japanese) Extinct volcano. Reputed resting place of Noah's Ark. First ascent 1829 (German)
Highest island-mountain peak in world. First ascent 1936 (Dutch)
First ascent unrecorded Shintoist sacred mountain, highest in Japan. Dormant volcano, last eruption 1707 Sacred mountain venerated by Buddhists, Moslems and Hindus
Active volcano, highest unbroken base-to-peak rise in the world (32,000 ft. from ocean bed) Highest peak in Dominion. First ascent 1894 (New Zealand) Highest peak on continent. First ascent unrecorded

An Original Masterpiece!

An old Moghul painting circa 1963 located
in the attic of our Art Studio at Bombay.

Information on this painting, the artist or
the model will be gratefully received by

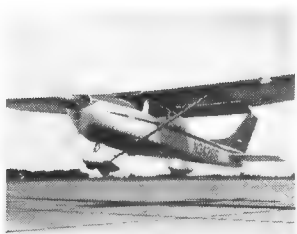


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medical & industrial microscopes, telescopes, binoculars, lenses, prisms, mirrors, levels, transits, auto collimators, optical comparators, ophthalmic instruments, optical glass, and the famous Nikon cameras and Nikkor lenses

Nikon makes light work for you



CESSNA

*Take a long look at the new
Cessna Skylane for 1963...
there's a lot to see!*

COMPARE THESE NEWEST DESIGN FEATURES: Spacious move-around cabin...two wide doors...Omni Vision...adjustable seats...deluxe interior appointments, and standard equipment including Cessna-Crafted Nav/Com radio gear...over-all, 3-color paint...wheel-speed fairings...tinted windows...gyros and vacuum systems...a full complement of flight and engine instruments...and a wide assortment of convenience items.

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Men Who Followed the Lure of the High Peaks

From the time when Leonardo da Vinci clambered up the southern slopes of the Pennines, Europeans have been the leaders in climbing the great mountains of the world. In this case "Europeans" most definitely include the English, from Sir Alfred Wills, who climbed the Alpine Wetterhorn (12,166 feet) in 1854, on his honeymoon, to the famous British climbers who finally fought their way to the top of the world, Mt. Everest, in 1953 (the honors went to New Zealander Edmund Hillary and Sherpa Tenzing Norgay, but it was British teamwork that made it possible).

One of the most famous, dramatic and tragic climbs was Edward Whymper's ascent in 1865 of the Matterhorn (14,685 feet) in the Pennine Alps between Switzerland and Italy. The Matterhorn was then supposed to be invincible. It is one of the most beautiful and dramatic peaks in the world, standing like a spike against the sky above the Swiss village of Zermatt, its sides appearing nearly vertical when viewed from the valley below.

Whymper was only 26 years old. He was, however, versed in the Alps. He had tried the Matterhorn seven times but, like many others, had failed. But then he discovered that what looks like a near-perpendicular slope reveals itself, when seen from a different angle, to be only a 40-degree grade. He also reasoned, from observing how the snow clung to the Matterhorn's upper flank, that what appeared to be an utterly smooth rock face was in actuality a series of terraces.

So Whymper decided in 1865 to try, for the first time, from the Swiss side. But he was stalled because he could not persuade his favorite guide, Carrel, an Italian, to go with him. Then one evening he met a 19-year-old Englishman, Lord Francis Douglas, a practiced climber, and they decided to join forces. In Zermatt they found Peter Taugwalder, a veteran guide, who agreed to come and bring along his son, "young Peter." As Whymper and Douglas were discussing their plans in a Zermatt hotel, in walked the Reverend Charles Hudson, perhaps the ablest English mountaineer of the day. He had two companions with him, a young man named Douglas Hadow, and the greatest guide from Chamonix, Michel-Auguste Croz. Hudson was also planning to try the Matterhorn. In a few moments the two parties had agreed to join forces. The charming informality of these arrangements was to prove a fatal mistake. Hadow had evidently represented himself to Hudson as an experienced climber, and Whymper took Hudson's word for it. Actually Hadow had only made two ascents in his life and had proved a bungler both times.

On the next fine day the expedition set out for the Matterhorn. They reached the top without incident, and the descent was going well until Hadow, whom the guide Croz had had to help most of the way, lost his footing and fell against the guide. Croz, taken by surprise and unable to bear the weight, fell backward with a cry. The rope pulled Hudson and then Douglas off balance. Whymper and the two Taugwalders, alerted by the cry, grabbed frantically at the nearest rocks. They felt a terrific jerk but held. Then, suddenly, they felt nothing. The rope had broken. As Whymper wrote later: "For a few seconds we saw our unfortunate companions sliding downwards on their backs, and spreading out their hands, endeavoring to save themselves. They passed from our sight uninjured, disappeared one by one, and fell from precipice to precipice on to the Matterhorn Glacier below, a distance of nearly 4,000 feet. So perished our comrades!"

The tragedy was still a live issue in Chamonix well into this century, for Croz's fellow townsmen remained convinced that their great guide could never have fallen unless there had been some kind of treachery. They insisted that Whymper or one of the Swiss guides had cut the rope to save himself. No evidence of this was ever brought forward, however, and the story slowly died. Since then at least 100,000 people have climbed the Matterhorn, including a 76-year-old man and an 11-year-old girl who made the ascent on the same day. However, during this same period the mountain



On the Eiger's North Wall in Switzerland, three climbers, roped together for safety, inch their way warily across a treacherous ice face.

has claimed more than 90 lives, among them four cocky young men who boasted in 1948 that they could get a cow to the summit, but were later found frozen to death.

A far more elaborate expedition than this disastrous English party was needed to conquer the Mountains of the Moon—the Ruwenzori range—along the boundary between Uganda and the Congo. These mountains are extraordinarily difficult to climb since they are protected near their summits by "Ruwenzori weather"—almost perpetual mists and rain and snow—and at their bases by thick jungle and spongy undergrowth. The first successful ascent of these peaks was organized carefully in 1906 by the Italian admiral and explorer, the Duke of Abruzzi, who led an expedition of more than 300 porters, six scientists, four Alpine guides, the great Alpine photographer Vittorio Sella, and a competent cook. The duke proceeded to map the range in detail and climbed both of the highest summits—Margherita (16,821 feet) and Alexandra (16,750 feet).

The greatest tests of man's ability to reach high places were the hardest to approach. Tibet and Nepal, in which the bulk of the Himalaya chain rises skyward, had traditional policies of excluding



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FIRST ON THE ATLANTIC
FIRST ON THE PACIFIC
FIRST IN LATIN AMERICA
FIRST 'ROUND THE WORLD

CLIMBING CONTINUED

Europeans. The first explorers of this highest of the world's mountain ranges were Englishmen and Indians. But by the 1940s, after the legal barriers had been lowered, the major assaults on the Himalayas began.

In 1950 a French group, led by Maurice Herzog, scaled Annapurna. Herzog himself, and Louis Lachenal, reached the summit. However, Herzog lost his gloves while taking pictures—he was suffering severely from lack of oxygen and hardly knew what he was doing—and the descent turned into pure nightmare. A storm hit, and Herzog nearly died of exposure; at one point he was thrown 500 feet by an avalanche. Back at Camp II he underwent the most excruciating antifrostbite injections, then had to be carried on a litter for almost four weeks, delirious and close to death, down through the passes and valleys back to civilization. On the way, Dr. Oudot, the team's physician, was forced to amputate all his fingers and toes. Louis Lachenal, also severely frostbitten, lost only his toes.



Edward Whymper conquered the Matterhorn in 1865 but the four lives it cost led Queen Victoria to propose that mountain climbing be outlawed.

There remained the tallest mountain of them all, brutal Everest, half a mile higher than Annapurna, a killer which had resisted more than 30 years of desperate struggle to conquer it.

In 1953 the British, under the leadership of Colonel John Hunt, mounted the most elaborate climbing expedition ever attempted. The climbers spent much more time than usual in acclimatizing themselves to the high altitude and then labored up the mountain's southwest face with five tons of equipment, much of it specially designed for the expedition. It took 362 porters to carry all these boxes from the supply base at Darjeeling in northeastern India. For more than 150 weary miles they trudged with their loads, up over passes 10,000 feet high, and down through hot, humid valleys barely 4,000 feet above sea level. Thirty-four experienced Sherpas came along to help when the glaciers were reached and the mountaineers began establishing their camps on the mountainside, each a little higher than the last. When the final assault was made, oxygen was used more extensively than ever before, both in climbing during the day and at night so that the user would not feel suffocated and be unable to sleep.

The last movement of this assault was conceived as a leapfrog operation. Two climbers, Tom Bourdillon and R. C. Evans, were to try first, leaving from a small camp some 3,300 feet below the summit, the eighth in a line strung out up the mountain's slope. Their support party, which included Colonel Hunt and several "tigers," as the high-climbing Sherpa porters were called, was to carry oxygen bottles and other supplies a little farther to Camp IX, which was to be simply the highest spot they could reach carrying heavy loads. In the event that Bourdillon and Evans failed, Edmund Hillary, a six-foot-three-inch New Zealander, and Tenzing Norgay, perhaps the most famous of the Sherpa tigers, were to proceed to Camp IX, rest overnight and then make the ultimate attempt.

Bourdillon and Evans did, in fact, fail, although they got within about 300 feet of the summit and reached a greater altitude than any climbers before them. Sick with exhaustion and disappointment, they still managed to give Hillary and Tenzing a minute description of what they would find after they had scaled the south summit which, from their perspective, hid the true summit from view. After having had to huddle in their tents at Camp

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CLIMBING CONTINUED

VIII for an extra day and night because of a severe storm, Hillary and Tenzing, with their support party, proceeded to a height of 27,900 feet and established Camp IX. The support party left and the two men spent the night alone. The next day, May 29, they set out on their famous journey. They went past the place where, almost exactly a year earlier, Tenzing and Raymond Lambert had had to turn back, past the place where Bourdillon and Evans had been forced to retreat, and finally, past the south summit, over a last steep cliff, and on up the last ridges to the top. Everest was conquered. Hillary and Tenzing, despite their overwhelming elation, managed to take a number of photographs and, mindful of all those before them who had tried and failed, searched for traces of Mallory and Irvine who vanished 800 feet from the top in a 1924 attempt. Then they descended and the whole party began its retreat to the glacier. Word of their successful ascent was flashed by radio to London on the eve of the coronation of Elizabeth II. Hillary and Colonel Hunt were both knighted by the new queen.

But mountaineering in the 1920s, '30s and '50s was not confined to the Himalayas. Many daring ascents were made in the Alps and the Dolomites, where climbers tried ever more difficult routes up peaks which had already been climbed by their easier slopes. In this kind of mountaineering, the emphasis was not on what mountain was ascended but *how*. The years between the two world wars saw a great deal of increasingly daring climbing. It ultimately led to a spirit of conquer-or-die known as the "cult of danger," which was unfortunately typical of a good deal of the climbing in these decades and especially of some German and Italian climbers who were spurred by intense nationalistic feelings. Climbing for the glory of the fatherland, for *Führer* or *Duce*, many tried rock faces beyond their skill, or anybody's skill, and fell to their deaths. The number of fatal accidents suffered in the Alps reached 400 in some years, a grotesque slaughter, but appropriate, perhaps, to a grotesque decade.

The climax of this mania came in 1936, when two German and two Austrian youths tried to scale the face of the Eigerwand, a mile-high precipice near the Jungfrau. Many had tried to climb it before, none had succeeded, and almost every party that had made the attempt had lost at least one climber. As people watched through telescopes from the porch of a nearby hotel, the four young men crept upward with agonizing slowness. They spent two nights standing upright, lashed to the rock with ropes. On the second night a storm enveloped the mountain and everyone expected them to be blown away, but on the third morning they could still be seen. By this time the young men must have known it was hopeless and they started down. But, weakened as they were from exposure, that was impossible now. They just clung to the rock,

motionless. Four guides banded together and tried to go to the rescue. But before they could get into a position to lower ropes, one of the young men lost his grip and plunged downward. The falling man's rope, getting twisted, nearly wrenched the head off one of his companions and a third was dragged downward and smashed against the rock face. The last young man cut the rope that bound him to these two corpses—the first to fall had gone all the way to the bottom—and almost managed to work his way to the guides; then he too lost his hold and fell to his death.



Even dogs have climbed mountains. The canine Alpine record is held by Tschingel who made 66 major ascents with W.A.B. Coolidge, Alpine writer.



Oceans into ponds

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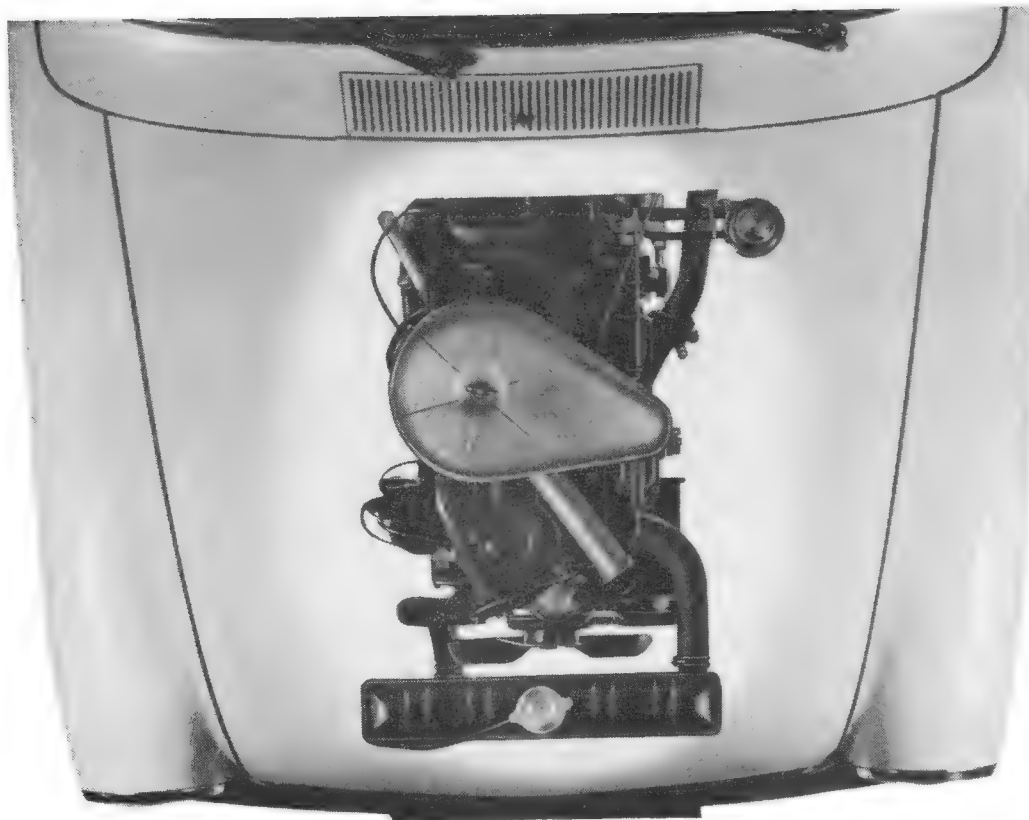
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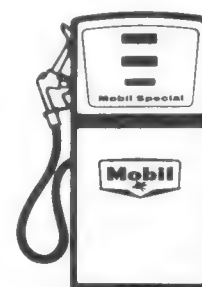
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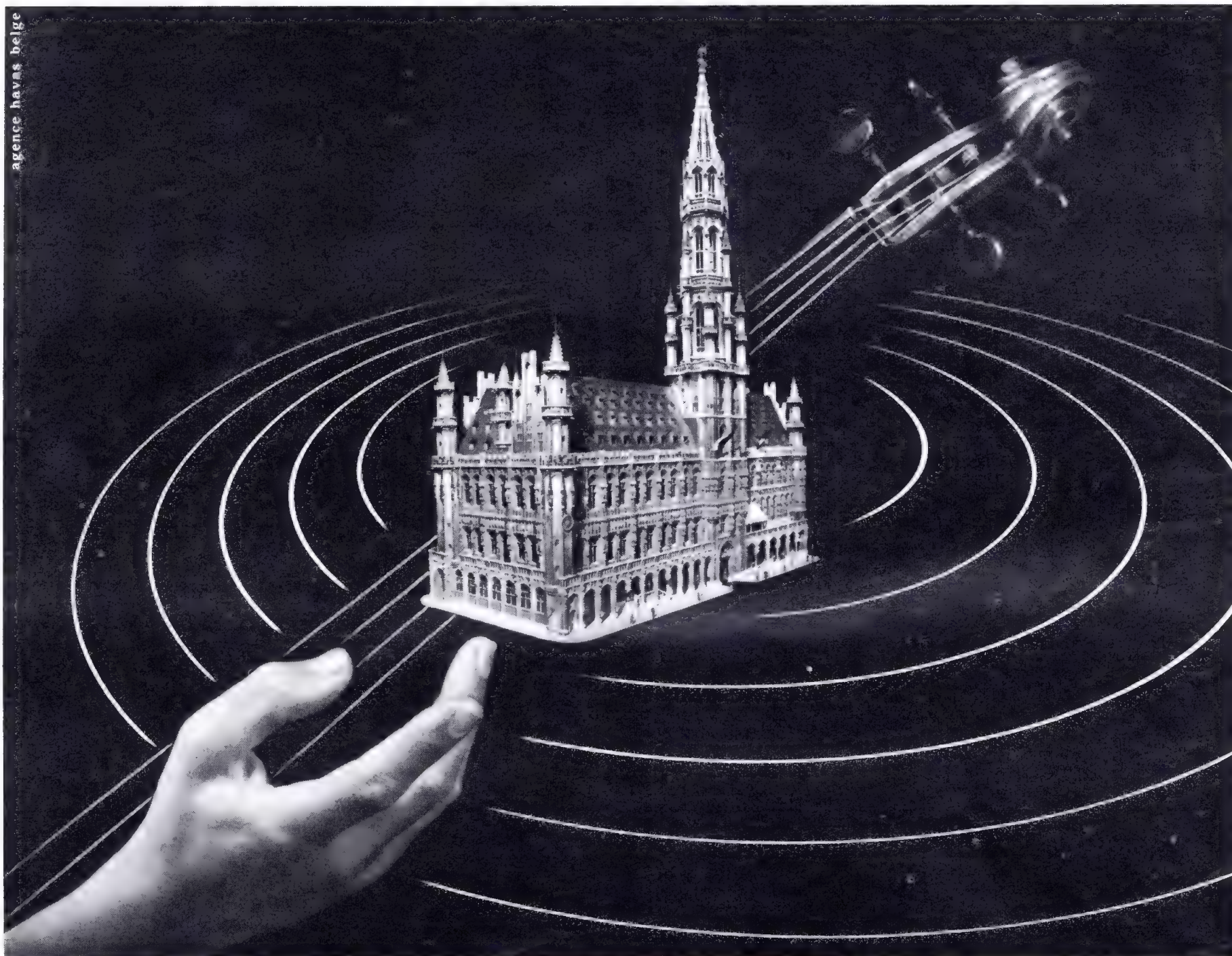
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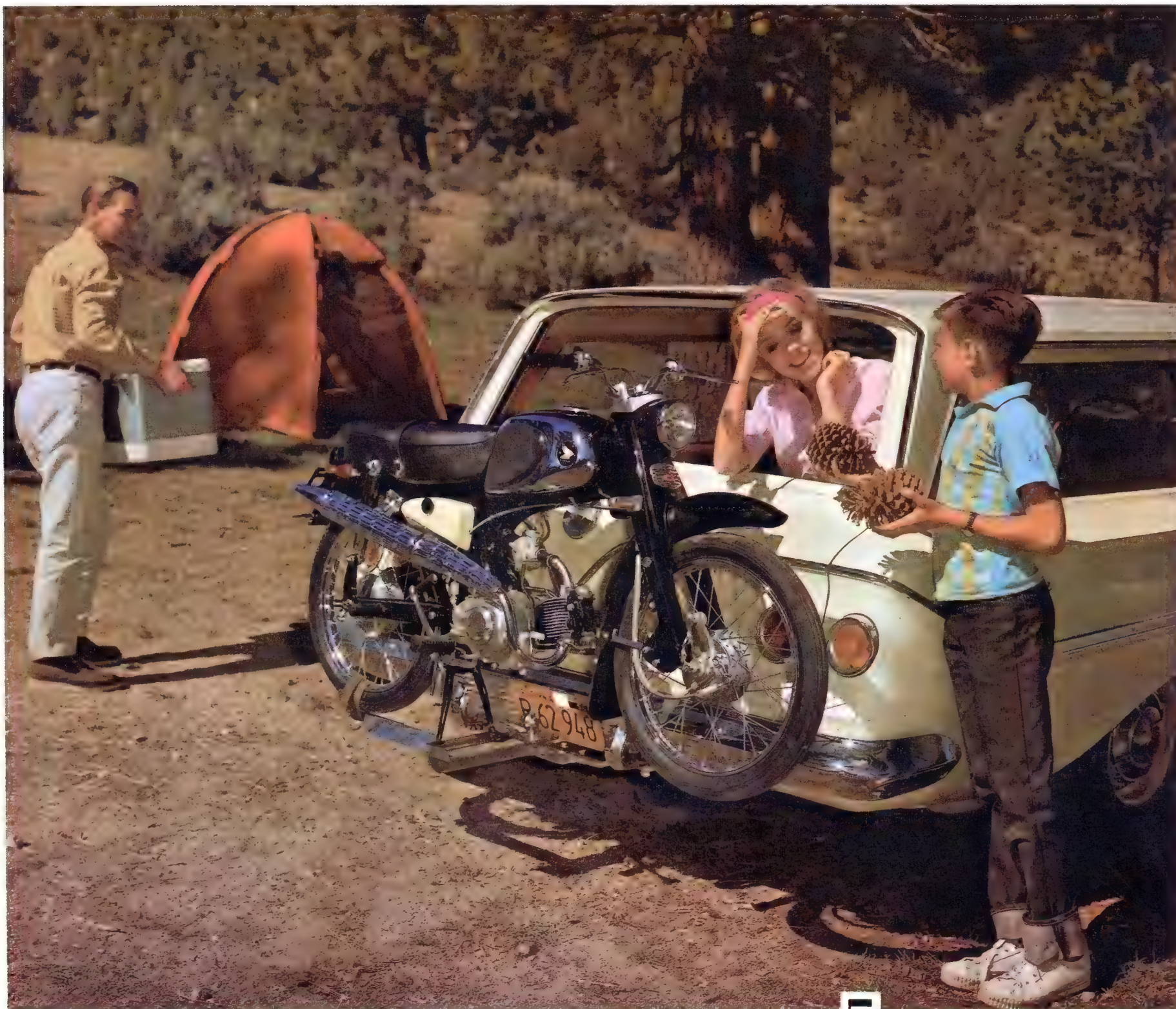
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THE FORESTS

*In infinite variety
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Born of the sea two billion years ago as algae floating through swamps upon the land, forests slowly evolved into the complexity of the Brazilian jungle shimmering in the sun at the right. Everything in forests everywhere—a mighty tree, the woodpecker hammering at its trunk, an insect boring into its wood—is part of the whole. The caterpillar that this year eats away the leaves may next year produce the butterfly that pollinates the tree. Shrubs, vines, herbs, ferns, mosses, and a multitude of animals and insects all fit into a mosaic that teems with life. So interdependent is everything that, assuming the same climatic conditions, a forest cut flat will, after a few centuries, reproduce itself about as it was.

It was in the forest that man grew up, learned to stand upright and developed his opposable but ever-useful thumb. In the forest he found building materials, food and fuel. Vast expanses of trees moderated his weather, stored his water, conserved his soil. But though his poets and philosophers sang praises to the wilderness, man became more and more a farmer and less and less keen about the forests. They sheltered wild beasts that might pounce out at him. They occupied land better put to crops. So the magnificent forests of Europe were cut, girdled and burned away, and in America, European settlers chopped their way from the Atlantic to the Pacific in a few hundred years.

Still the forests persist. They take up a third of the earth's land surface, circling the globe

in great belts. In the far north comes the treeless arctic tundra with thickets of dwarf alder, birch and willow. Below that is a conifer (or cone-bearing) belt of spruce, pine, fir and hemlock, running from Norway around Russia, Siberia and Canada, called the taiga (from a Russian word meaning swamp forest). Next are the deciduous (or leaf-shedding) forests of oak, beech and maple in the eastern United States and western Europe. Around the world's middle are the tropical "rain" forests of teak, mahogany and ebony, the tropical "winter" forests that shed their leaves in dry seasons and the tropical "gallery" forests that follow the riverbeds.

In detail, of course, things are rarely so neat. Forests on the rainy sides of mountains are different from those on the dry side and sweet soil produces different trees from those produced by sour soil. Special conditions of soil, water and temperature produce such spectacular results as the giant sequoias on the western slopes of the Sierra Nevadas and the Pacific coastlands, the rain forest in the temperate state of Washington, and the dry, leathery chaparral and saguaro cactus forests of the American Southwest. As the pictures on the following pages show, there is a vast variety. In the U.S. alone, 147 different forest types containing various combinations of 1,182 tree species have been recognized. And in British Guiana, on such a site as that at the right, botanists counted 86 species growing on five acres.



Standing on a slope in the rain forest not far from Rio de Janeiro, Brazil, is this giant ceiba tree festooned with moss, orchids and epiphytes vines whose dangling roots live on wind-borne soil dust or are sustained by seed

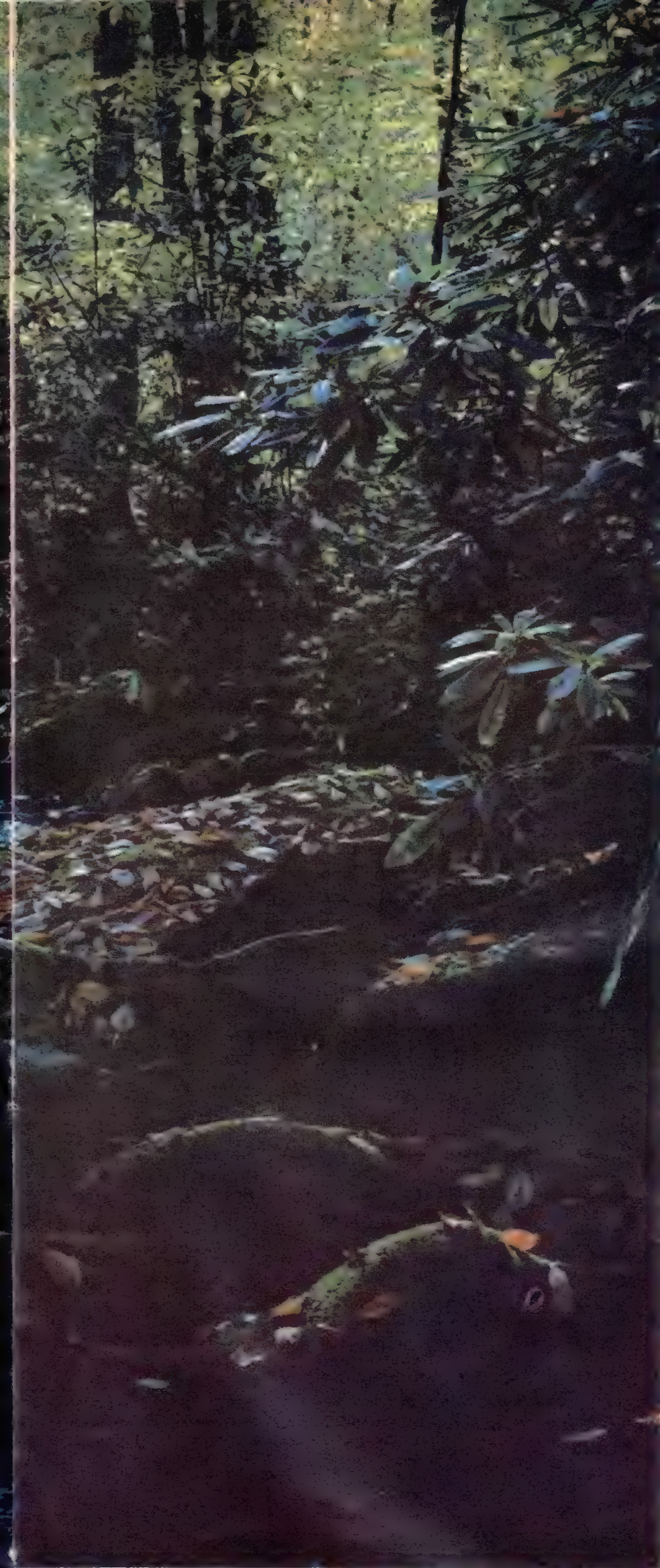
and soil debris carried to them by ants which nest in their roots. A century and a quarter ago Charles Darwin, the famous English naturalist, came here to admire the foliage and study the insect life. The tree then was 200 years old.



Spring, summer and fall the extremes of climate in the eastern United States produce splendors in color rarely matched anywhere else on earth. Here, in the Great Smoky Mountains National Park, a

507,159-acre reserve in North Carolina and Tennessee, a mountain stream tumbles through hot summer woodlands alive only with flowers—and with bumblebees, hatching Mayflies and humming cicadas.

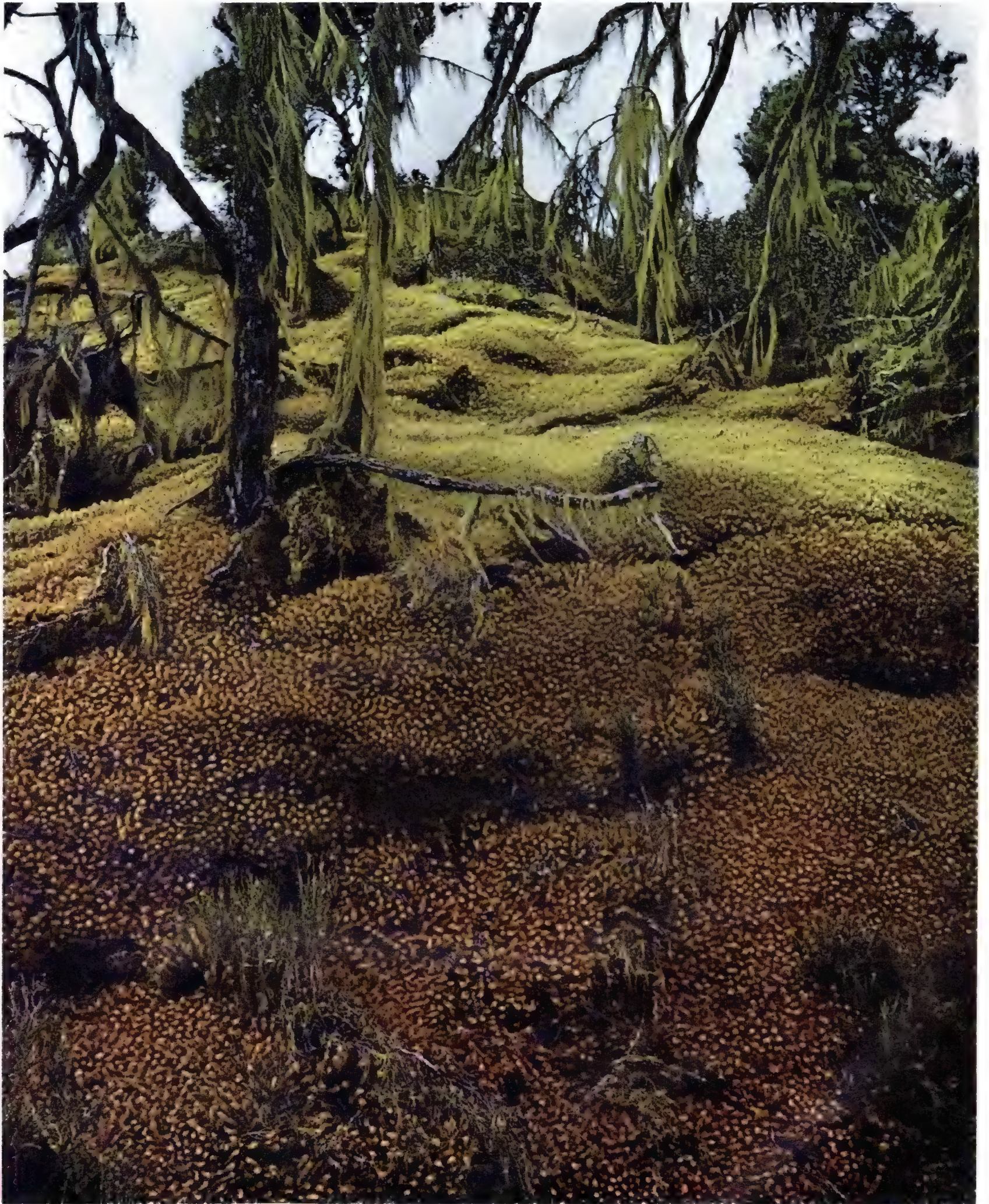
The woodlands' seasonal show



In the spring the same forest parkland stages the display at the right—a carpet of white-fringed *Phacelia* on the forest floor. There are about 1,300 species of flowering plants in these mountains.



Tropical Africa's gothic greenery



The coastal jungles of Nigeria (*left*) yield palm fruit oil for margarine, soap and special lubricants for steel mills. A large part of the region has been cleared (if that is the word) for such plantations as the one shown here.

A strange forest of gnarled heather trees, 40-foot brothers of the delicate little bushes that grow in Scotland, flourishes in the cold moss beds of the Heath Zone on the Mountains of the Moon (Ruwenzori) in equatorial Africa.

The dense and teeming jungle

The trees in the pictures here are so dense that a daytime world underneath them lives in half-light and silence. Plants reach up as high as 300 feet for sunlight. Tree trunks are enormous and the vines of climbers, clinging to the trees, are often longer than the trees. Save where the sun can reach down and encourage rank growth the floor of the forest is hard soil. A fallen branch quickly vanishes, decomposed by teeming fungi, bacteria and insects. Everything is quiet. Then, at sundown, the jungle erupts. Parakeets and parrots fly screaming to their nests. Crickets and katydids set up rasping choruses. Howler monkeys roar. And there are anonymous rustlings—opossums, mice and lizards moving about, anteaters ripping open termite nests, tapirs snorting, and the soft step of a man seeking food.

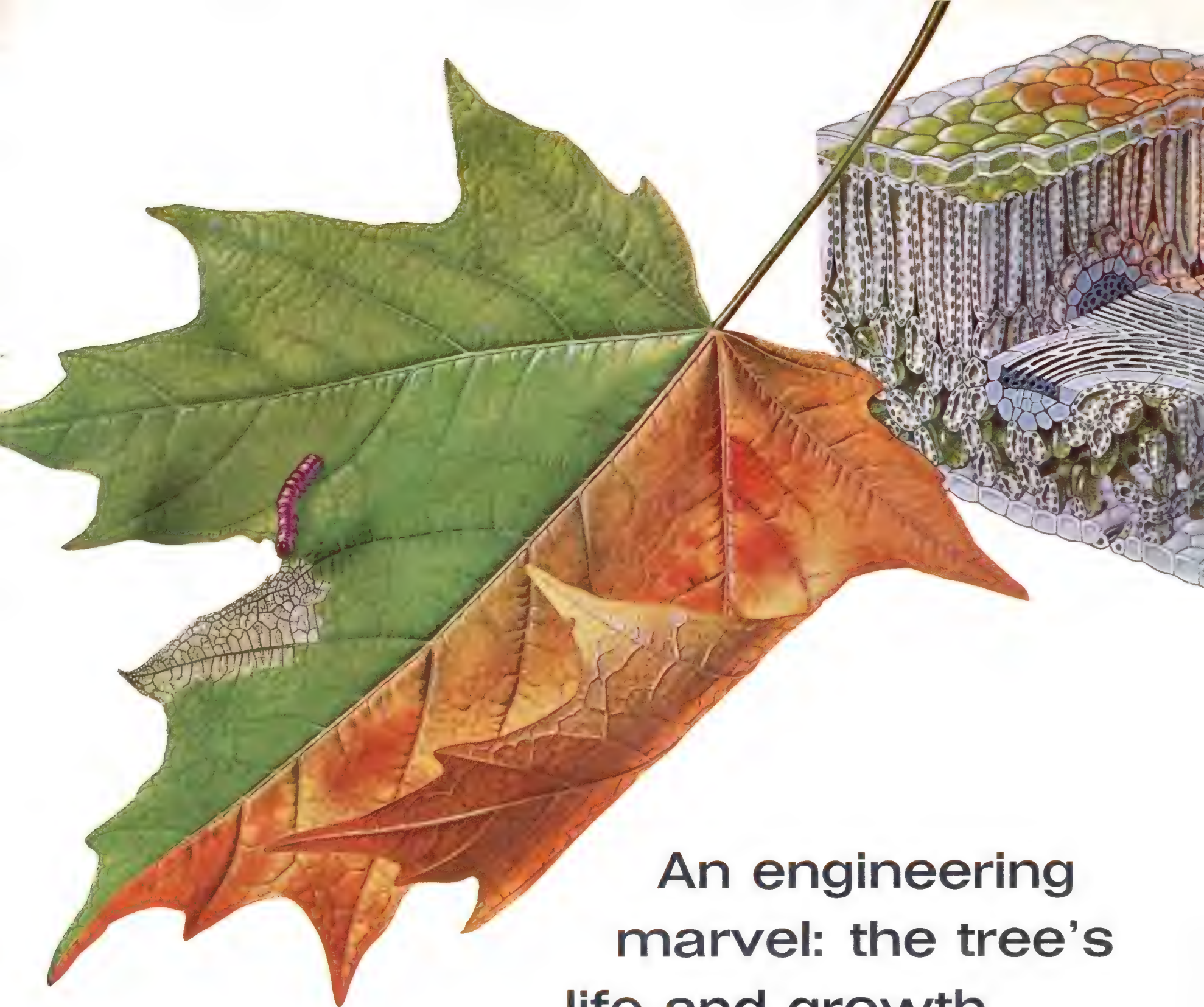


The cut through the rain forest (*left, above*) will require constant work, for things grow back extremely quickly in the tropics. This is a road linking Brazil's new inland capital, Brasilia, to the river port of Belém 340 miles away.



Tall trees that seem to be blooming orchids (*above*) are part of a submontane forest in the Amazon River basin reaching clump after clump for endless miles. It is forever green, forever hot and the rainfall sometimes exceeds 100

inches a year. In some places the forest is impassable, a monstrous tangle of orchid vines and creepy climbers. But more often it is open ground and primitive Indians live there, depending on Mother Jungle for all their needs.



An engineering marvel: the tree's life and growth

The central fact of the forest, the tree, is an organism full of marvels. Starting as a wind-blown speck of seed it may grow 350 feet tall, become as imposing as a medieval cathedral and strong enough to split rocks. It mixes sunlight, water and air to manufacture its own food in a process called photosynthesis (*described right above, in the caption for the leaf*). It often looks majestically serene and peaceful. But with an absorbing system 100 times more efficient than the best suction pump ever made, it continuously draws up from the ground 1,000 times more water than it needs. And to hold its ground for itself a tree attacks other trees with poisons so subtle that scientists have only just caught on to the war and begun to study it.

The wonders of a tree start in the living roots. These are not the old, massive, twisted arms that plunge into the ground at the foot of many trees, important as those are in anchoring the tree against the wind. The roots that absorb water are delicate things, perhaps an inch long and thinner than a piece of string. They probe as much as 40 feet under the ground. There are millions of them in any tree's root system, each one provided with a protective cap

which it pushes around in front of it. Some also are provided with an oily solution to make the going easier. Behind the root tip as it grows out into the earth come tiny white root hairs which absorb water and minerals from the soil and send them up the tree's trunk to the leaves.

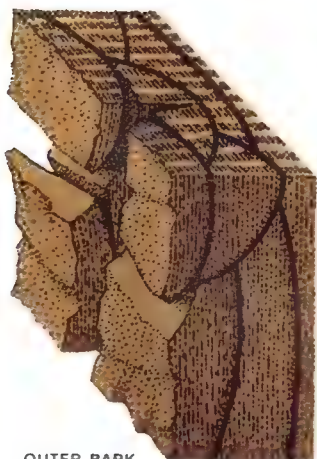
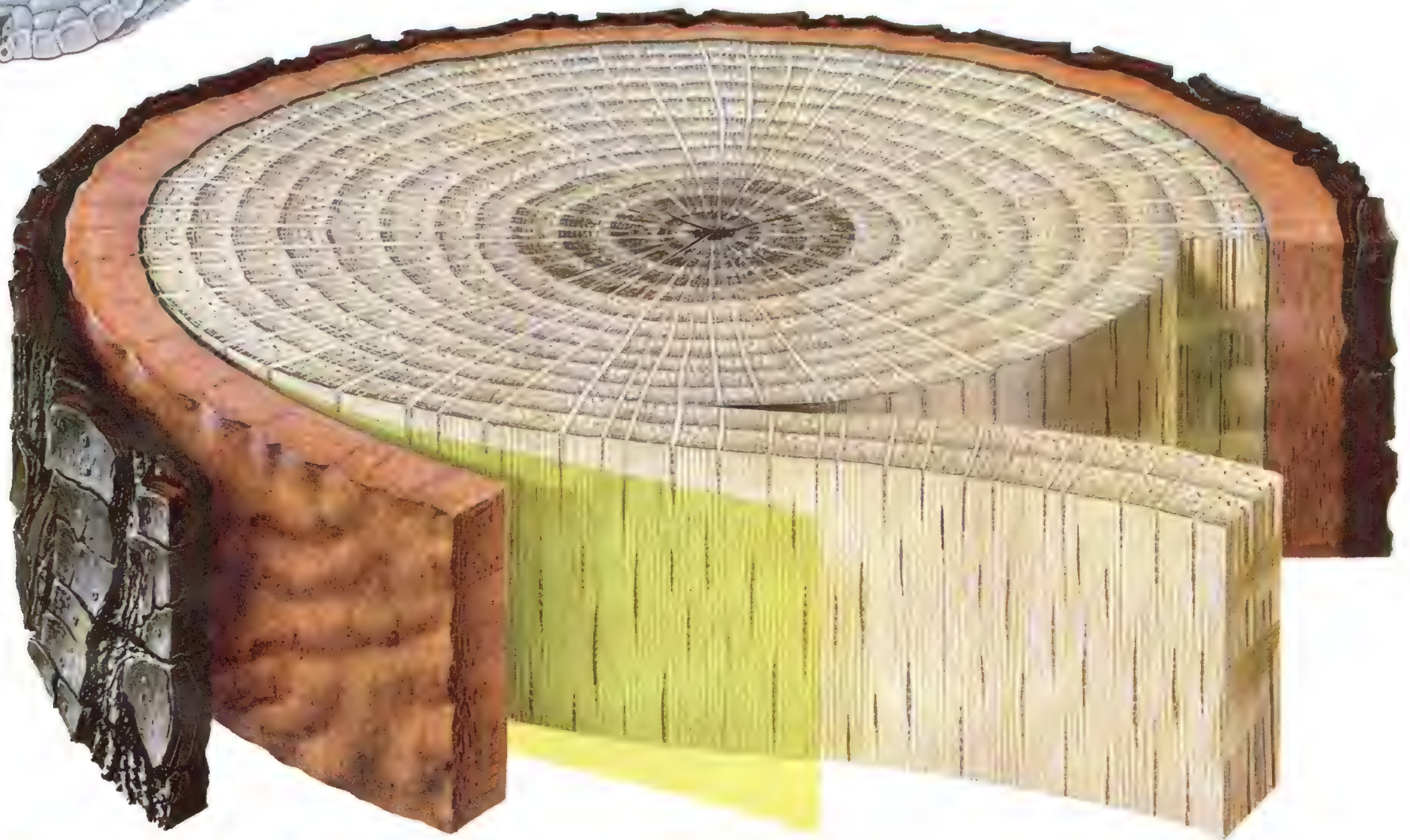
In the trunk above the roots only a small part of the tree is alive at any one time. The inner core (*as explained far right, above, in the caption on the trunk*) is usually dead. Sometimes all of the tree save a few outer inches may be dead and the tree, though weak in a wind, will continue to function normally. But the rings of healthy wood around the dead core cannot reproduce themselves, though they continue to function, carrying water and nutrients up the trunk and branches.

A single birch tree on a summer's day may pull out of the earth and evaporate through its 200,000 leaves as much as 900 gallons of water by transpiration. Exactly how transpiration works is still a mystery, but it is known that at least five different processes are involved. It may be that the leaf, when it loses a drop, can exert a force of up to 400 pounds per inch to draw a new drop from the tree.



On the sugar maple leaf (*far left*) a caterpillar eats away the soft green parts to show the structure of the vein system. The lower half of the leaf is shown in its brilliant autumnal colors. Leaves feed trees when sunshine enters the leaf from above, carbon dioxide from below, and water from the ground via the tree. In the leaf's horizontal and looped vertical layers of tiny green bodies called chloroplasts (*near left*), the energy of sunlight initiates a series of chemical changes which eventually produce the tree's food, energy-rich carbohydrate or sugar.

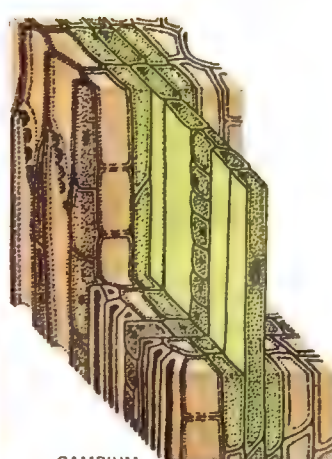
Trees thicken in rings; in temperate zones hardwoods usually add a ring a year. But all parts of the tree do not expand. The part that adds to the tree's girth is a paper-thin tissue of cambium cells (*shown in yellow-green below*). They divide and the new cells on the inside become xylem, or wood, while the outer ones become phloem. In a year or two the phloem is cut off from the water and food inside the tree. It slowly begins to die and helps form the outer bark of the tree. The gum-clogged inner-core xylem also dies and forms the tree's heartwood.



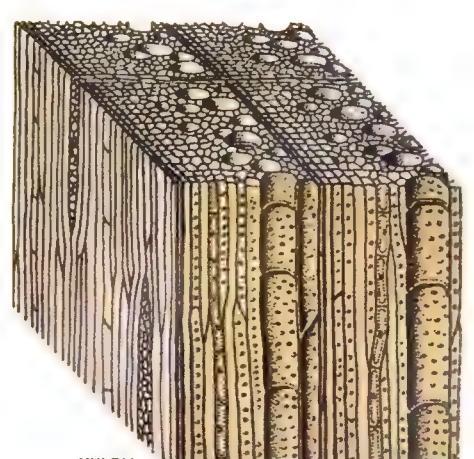
OUTER BARK



PHLOEM



CAMBIUM



XYLEM



The glaring orbs of Brazil's fire beetle are not eyes. They are body patches that simulate the angry glare of a big beast.

A SPECIALIZED LIFE

Beasts, bugs and birds adapt to forest life



No part of our land supports a greater concentration of life than the forest. Because of the competition, specialization means the difference between life and death. Beasts and bugs alike blend into the foliage. Frogs with stickum on their feet climb smooth trees. Woodpeckers beat their heads against trees 20 times a second and never get a headache. Owls zoom about in near

darkness and never hit a branch. Darting hawks, with outsized tails and secondary flaplike wing feathers, swoop through the tangles. The North American flying squirrel and the Australian phalanger have skin flaps that act as parachutes and permit them to make gliding flights from tree to tree. Thus nature adapts to both hospitable habitat and inhospitable inhabitants.

In a plant-clogged pool a jaguar all but blends into the foliage. Jaguars also lurk in trees waiting for their unwary prey.



All dusted with pollen, a solitary bee gathers nectar from a blossom of goldenrod. The majority of bees are not social insects like the honeybee. They are solitaires living all alone or in the most rudimentary communities.

Sometimes the females will share a common burrow with other females but each builds and maintains its own separate chamber for eggs off the main tunnel. It stocks this with food and carefully seals it away from the others.



A royal blue Morpho butterfly (*above*) feeds on leaves. The wingspan of these butterflies often reaches six inches and pieces are frequently worked into jewelry and paintings because their iridescent color endures long after death.

Perched on blades of grass two ticks (*below*) wait patiently to attach themselves to some passing animal. They will then feed themselves by sucking its blood. They may also infect it with the dreaded Rocky Mountain fever.

Tiny monsters

Insects are everywhere in the forests, dancing about in the summer air and filling it with buzz. They both eat one another up and politely make room for each other. For example, 20 insect species dine on the white pine; but they divide it—perhaps according to taste—five attack the foliage, four the cambium layer, three the buds, three more the twigs, two the wood, two more the roots and one gets the leftovers—the bark.



A whirring mosquito operates on only two fragile wings. By setting up harmonic vibrations in the air and in its own thorax it gets more flaps from these wings than its nerves or muscles could ever possibly sustain alone.





The Brazilian caracara is a member of the falcon tribe, distantly related to the goshawks and the peregrines of Europe. Its habits, however,

differ greatly from those of its hunting kin. It is a carrion eater and its reputation among those who know it best is that of a cowardly bird.



Looking amazingly like an owl, the hawk eagle patrols the South American forests from Brazil to Paraguay. Soaring lazily in the sky above the

Winged marauders

The abundance of insects in forests brings the little birds, and the abundance of little birds (plus snakes, rats and other succulent tidbits) brings the big birds shown on these pages. Inside the forest, birds arrange themselves in complex relationships, depending upon their nesting and feeding habits. The ruffed grouse, oven bird, hermit thrush and junco nest almost exclusively on the forest floor. The burrowing owl (*shown right*) nests under it. Some birds like deciduous trees, others evergreens. By accepting well-defined nesting places birds permit a larger variety of species to occupy the same forest. In one New York state forest Blackburnian warblers were noted taking the tops of evergreens, black-throated green warblers the middle branches and magnolia warblers the lowest. Some warblers selected shaded and others sunlit shrubs. But crows, hawks and eagles took the top branches. From there it is often but a short swift dive to supper.



treetops or sitting amid the topmost branches, it bides its time until it glimpses a snake, lizard or rodent, then dives straight down upon its prey.



Gaudiest member of a family which has produced the biggest birds that ever cleft the skies is the king vulture. Its keen eyesight enables it to

discern food from great distances. When one descends for a feast, other king vultures notice from afar and hasten to share the free dinner.



The tiny burrowing owl nests in tunnels originally drilled by armadillos and rodents. After it lays its eggs at the bottom the owl stands watch "like a sentinel" at the mouth of the usurped tunnel. It eats mice, snakes and insects.



The hawk-headed parrot, named for its ruff feathers and piercing eye, is a popular pet, easily tamed and quick at learning tricks. When free it travels in groups and keeps the forest evenings noisy with its raucous screams.



Twisted aspens form the "Crooked Forest" on the northern rim of Arizona's Grand Canyon. The trees were bent as saplings by winds and snow.

The Hidden World of the Soil



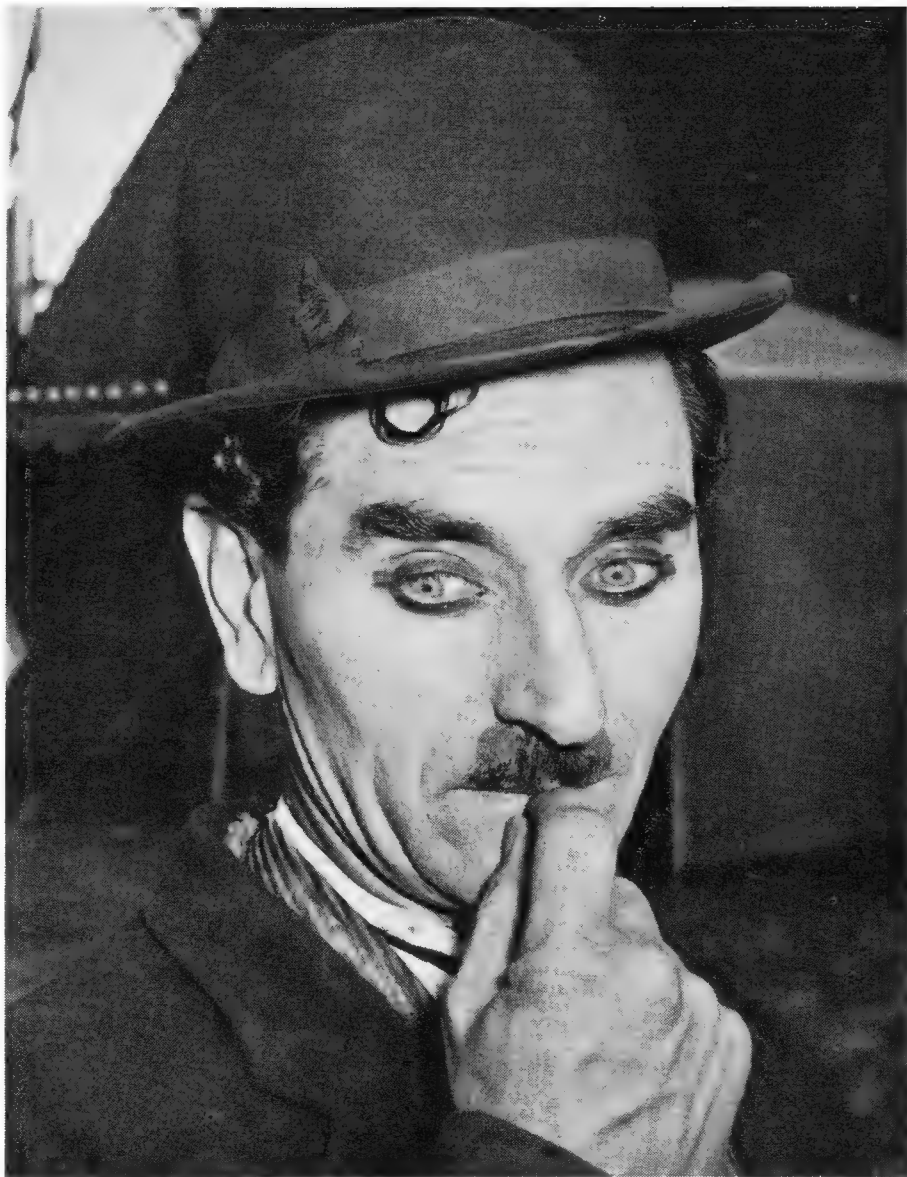
The trunk of a feeble oak is festooned with bracket fungus. Fungi attack sick trees, riddling their tissues with fibers that eventually kill them.

The dead leaves, needles, twigs and fallen branches that lie in heaps upon the forest floor appear at a casual glance to be a lifeless, rotting mass. Actually, they form the roof tops of the hidden world of the forest soil. The soil veneer shelters more life than can be found in any other stratum of the forest, or probably any other environment on earth, for that matter. The inhabitants exist in numbers that stagger the imagination. They carpet the grains of soil and weave passageways through them; they dig out burrows and tunnels and underground nests. The honeycombs of moles, the burrows of worms often form such a labyrinth in the forest floor that it has the springy feel of foam rubber. Some years ago, scientists blocked off a small section of forest soil in New York State and removed the top layer of earth to a depth of one inch. They made a careful count of the insects and other invertebrates found among the soil crumbs. In all, there was an average of 1,356 living creatures present in each square foot, including 865 mites,

265 springtails, 22 millepedes, 19 adult beetles and various numbers of 12 other forms. Had an estimate also been made of the microscopic population, it might have ranged up to two billion bacteria and many millions of fungi, protozoa and algae per *teaspoonful* of soil.

The forest floor is also a crossroads through which pass above-ground forms that spend part of their lives in the subterranean darkness. About 95 per cent of all the insect species in the world invade the soil in either the egg, larval, pupal or adult stages; the longest-term tenant is a species of cicada which passes 17 years of its nymphal life in the soil and the remaining few weeks of its life as an adult sucking sap from the trees. Many animals spend their resting hours in burrows in the earth. And, of course, plants span both worlds of sunlight and darkness; there is a special place on the plant, called the crown, where the stem and roots meet.

Underground is a scene of considerable turmoil, for massive



This is an example of work by Mr. Crogscheepers of South Africa with an Asahi Pentax with Takumar 105mm f/2.8 lens.

HOLD THAT CLOWN

with an

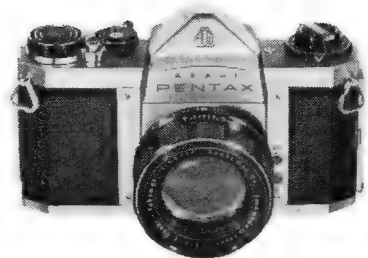
ASAHI PENTAX

This circus clown is not shy. He likes to have his picture taken with an Asahi Pentax. He knows that his portrait will be razor sharp because the photographer is composing and focussing through the same lens which will make the picture.

Furthermore, the telephoto lens makes possible dramatic shots like this from a distance; the subject is brought forward, artistically blurring the background. In- and out-of-focus areas are clearly visible through the viewfinder, brightened with the cross-micro prism Fresnel lens. There are fifteen interchangeable lenses for the Asahi Pentax, making possible an infinite variety of photographic opportunities.

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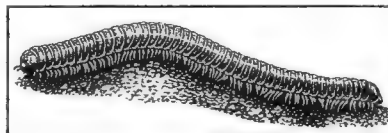
SOIL CONTINUED

works are being accomplished. Every year, roughly two tons of plant and animal detritus—leaves, twigs, branches, animal droppings, insect corpses—fall like rain upon an acre of forest floor. Were it not for the work of the soil creatures, the forest would soon be choked in its own wastes. Essential supplies of substances necessary for plant growth would be locked up in these dead remains and renewal of the forest would cease. Air or water could not reach the tree roots through the thin layer of matted leaves and heaps of vegetation.

But the detritus is turned under, plowed and furrowed, broken down into its constituent chemical parts, mixed with the soil grains in a continuing cycle that insures the perpetual rebirth of the forest. In time, everything that lives in the forest returns to the soil, where it is transformed. When alive, the tissues were made up of complex substances—but slowly they are converted again into the simple chemicals from which they were built. Everyone has witnessed a part of this process, commonly known as decay, or rotting, and most people regard it as a spontaneous chemical change. This is not so: decomposition consists of a long and intricate series of steps, not at all clearly understood by scientists, in which a procession of soil creatures with complex interrelationships takes part in attacking the detritus. There is nothing haphazard about the order in which the litter is eaten, mixed and eaten again until it has become what is commonly known as humus.

Only a relatively small number of the soil animals can feed on freshly fallen plant matter before it has been softened and predigested by bacteria and fungi. One that can is the termite, which is able to eat the tissues of dead-wood because the protozoa it carries in its stomach digest the wood's tough cellulose. Another is the earthworm, a flexible tube into which go leaves and mineral particles. At its pointed front end, protruding "lips" are pushed out which moisten leaf particles with enzymes so that they are partially predigested before they enter the worm's body. They then pass into the esophagus, where glands secrete a calcium compound serving to neutralize the acids in the leaf tissue. A gizzard grinds up the particles into pieces, which are then further refined in a digestive tract extending through 80 additional segments of the worm's body. What emerges are the worm's castings, tiny mounds which cover the forest floor and which may often be seen on garden paths.

Artistotle regarded earthworms as "the intestines of the earth," but the first person to understand the importance



Millepedes thrive in moist areas and generally eat decaying vegetable matter although a few species eat growing plants. They can actually have as many as 200 legs although never the thousand feet their name indicates.

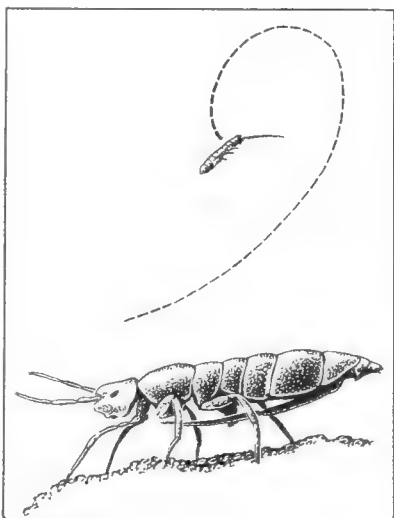
of the earthworm as a soil factor was Gilbert White, the 18th Century British naturalist. He stated with some exaggeration, "Earthworms, though in appearance a small and despicable link in the chain of nature, yet if lost, would make a lamentable chasm. . . . The earth without them would soon become cold; hard-bound, and void of fermentation; and consequently sterile." It was Charles Dar-

win who actually tried to determine scientifically the earthworm's importance. After lengthy observations and experiments, some of them spanning nearly his whole scientific life, Darwin concluded that on a single acre earthworms each year passed through their bodies enough soil and litter to produce between seven and a half and 18 tons of castings. It is now known that, on some soils at least, Darwin's estimate was highly conservative: one investigator in Africa concluded that 107 tons of castings per acre were deposited during a six-month rainy season. Earthworms rarely eat certain kinds of leaves, such as oak and pine, and are consequently rather scarce where those trees grow. But in areas of favored trees (aspen, ash,

hickory, dogwood and basswood), the top several inches of soil may be made up almost entirely of their castings, and there may be millions of worms to an acre.

Most of the other soil animals—such as millepedes, mites, springtails and pill bugs—are unable to digest fresh litter until it has been softened by microorganisms. But then they attack it relentlessly, chewing and grinding it and depositing it as ever-smaller pieces. As the pieces of leaf become smaller and smaller, their combined surface area increases greatly—and thus provides a vast living space for more and more soil microbes. Bacteria feed on these leaf particles, building their energy from the sugars and starches that were originally in the leaves and, in the process, liberating the carbon dioxide that the tree took in through the leaves to carry on photosynthesis. The carbon dioxide is released into the soil and from there it filters back into the atmosphere, where it will someday be re-used by the green plants.

But the principal agents in the reduction of litter to humus in a forest are the fungi; in many woodland soils, their bulk alone equals the combined weight of all other soil life. They are the scavengers that can decompose almost anything the bacteria do not tackle (and having done so, many of them in turn serve as food for bacteria). They are the chief decomposers, for example, of lignin, one of the main constituents of wood, which is bacteria-resistant. The fungi form many cogs in the machinery of disintegration, starting with the trunks and branches of downed trees. They reduce these hulks of wood to smaller pieces, at which point other kinds of fungi take over, continually softening and reducing the wood to simpler substances. They are vital in the workings of the coniferous forest, for few animals, if any, can attack a newly fallen evergreen needle. However, as soon as a fungus has partially softened a needle, soil invertebrates are able to lay eggs in it and their young continue the process of disintegration.



Springtails are called primitively wingless because, unlike most insects, they display no evolutionary evidence of ever having had wings. By using the triggerlike mechanism extending under the abdomen, they can jump high.

Much of the humus of forest soil is made by fungi, and a goodly amount of the organic matter in the soil consists of their own decaying structures; their ghostlike filaments lace the soil with a fine mesh and often actually bind the soil particles in place. A single ounce of forest soil may contain nearly two miles of fungus strands. A fungus spore, upon germinating, produces a threadlike white strand called a hypha which grows and lengthens, branches and rebranches. Each thread branches into more threads, perhaps every half hour, and each sub-branch may grow at the rate of a hundredth of an inch an hour. In that way, in only a few days under favorable conditions a fungus may grow miles of strands. The hyphae secrete enzymes and acids that attack the litter, predigest it and break it down into simpler substances that are then absorbed into the fungus. Fungi are among the most economical feeders known; they can retain for building their own structures as much as half of the food they absorb. The absorbed nutrients are immediately put to work to manufacture new cells to attack wood and more enzymes and acids, and so on, endlessly.

To a walker in the woods, the most conspicuous evidence of fungi is a short-lived reproductive phase, the toadstool, or mushroom (an edible toadstool). The toadstool, which appears to rise magically out of the litter after a warm rain, starts as a little ball that grows in the direction of the soil surface from the underground bundle



HIGHLAND QUEEN

SCOTCH WHISKY

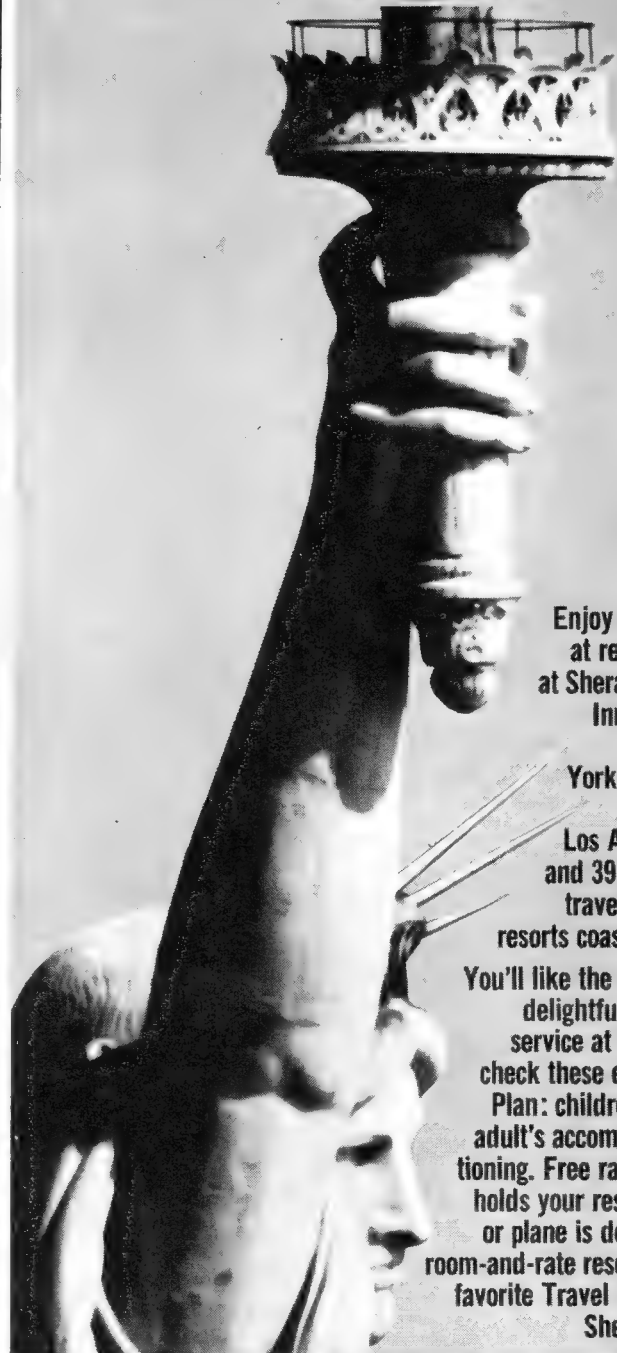
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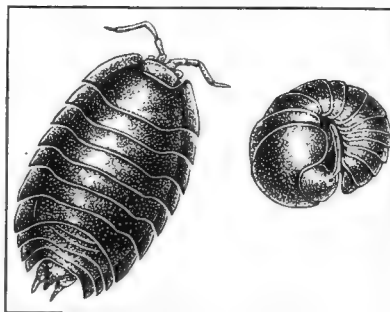
SHERATON HOTELS AND MOTOR INNS

Coast to coast in the U.S.A., in Hawaii, Canada, Nassau, Jamaica, Mexico, Venezuela, and Israel

SOIL CONTINUED

of strands. All parts of the toadstool—its umbrella and stalk and spore-shedding mechanism—are mapped out in this little ball, much like a balloon before it is blown up. After a rain, it absorbs water and nutrients and surges through the soil surface. Usually on the underside of the umbrella are gills, or pores, from which clouds of reproductive spores are shed to be carried by wind. They are

not shed all at once; instead salvo after salvo of ripened spores bursts into the air. If a fresh toadstool is brought from the woods into a darkened room and a flashlight held under the gills, the spores may be seen raining down like motes in a sunbeam. The number of spores released by some forest toadstools is staggering—some individuals even send out hundreds of millions an hour, and there may be a dozen of these toadstools perched on a single fallen log.



Wood lice, also called pill bugs because they curl up when disturbed, are more like crabs than insects. Often found under logs, they feed (as do two soil animals already shown) on food presoftened by microorganisms.

Many forest trees enter into a partnership with soil fungi and appear to gain a

major part of their nourishment from the hyphae that either mantle their roots or else penetrate the root cells themselves. Roots of this kind are known as mycorrhizae or "fungus roots"—neither roots nor fungi alone, but special structures formed by the combination of the two. The extent of fungus roots is not known for certain, but the partnership is undoubtedly widespread. In recent years it has been learned that they even exist on the roots of some agricultural crops.

What benefit does each member of this strange partnership receive? The trees are undoubtedly able to survive in many places because the fungus partner is an efficient collector of necessary nourishment, which it serves to the tree roots; the tree may also receive from the fungus certain growth-promoting substances. About 90 per cent of the absorbing roots of a conifer are likely to be surrounded by a mantle of fungus, and the fungus roots may be the reason that conifers are able to grow in inhospitable locations. For example, the growth of white-pine seedlings possessing many fungus roots was once experimentally compared with the growth of pines that had very few fungus partners. After a short time the former weighed nearly twice as much, and had absorbed from the soil 86 per cent more nitrogen, 75 per cent more potassium, 234 per cent more phosphorus than the latter. In return, the fungus appears to receive from the tree roots certain elements which may be important for its own growth and reproduction; also, by attaching themselves to the tree roots, some fungi seem to benefit by having staked out a province where they appear to be free from the competition of other fungi, bacteria and soil insects. In any event, there has been great controversy among scientists as to whether the fungus is merely a parasite on the tree, whether a full-scale partnership exists that gives mutual benefits or whether the tree and fungus have worked out some sort of uneasy truce.

As in the above-ground world, the hordes of soil life have attracted predators. The myriad strands of fungi are a constant food supply for many small soil dwellers—mites, springtails, beetles and gnats. Through the forest floor swarm animals that feed indiscriminately on each other or on the smaller decay-causing creatures. Centipedes and pseudoscorpions comb the upper layers of the litter, and speedy predaceous beetles prowl through the miniature jungle of the surface. Ants are everywhere. In the tropical forest, the army ants of the New World and the driver ants of Africa send out raiding columns that devour every living thing that cannot fly or flee at great

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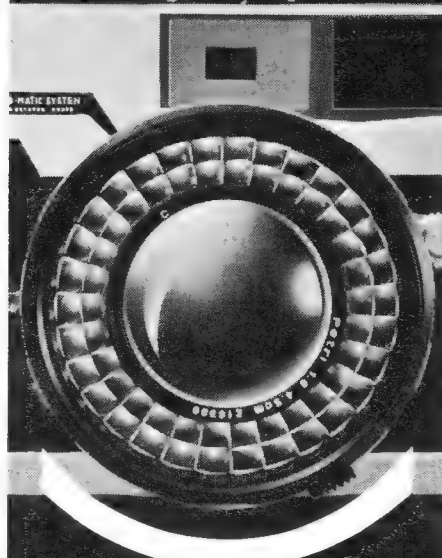
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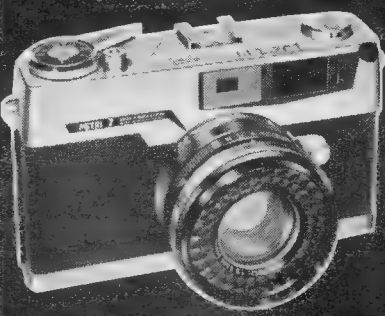
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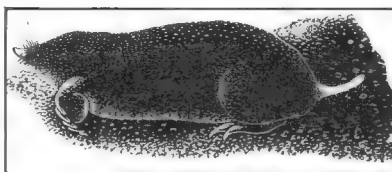
SOIL CONTINUED

speed. The little shrew is untiring as it races about in its search for insects, worms and rodents. This bundle of energy, sometimes only two or three inches from snout to tail tip, burns tissue with startling rapidity. It carries on its body processes at a speed faster than any other vertebrate animal's, except for the hummingbird. It must eat constantly, at least once an hour, to maintain its breakneck pace of living and wears itself out in little over a year.

The mole plows the forest soil in its ceaseless search for insects and worms. Its runways are often conspicuous, for when burrowing in the upper layers of soil it lifts ridges that wind across the floor. The mole is marvelously adapted to its life as a bulldozer, with an elongated body which enables it to fit through narrow tunnels in the earth. The limbs are short and strong, built not for speed but for moving quantities of earth. Its fur is so arranged that it does not muss even when the animal is moving backwards, and thus offers little resistance to the passage through the soil. Its front paws are in the shape of shovels, equipped with strong claws and so attached that they are twisted outward. Thus the mole's progress through the soil is similar to that of a human swimmer doing a crawl. With constant strokes, the mole works its way through the soil, churning perhaps 300 feet of tunnels a day.

The broader architecture of the soil is revealed whenever a road is cut through a forest. Then it can be seen that the soil is built up of a number of different layers, called horizons, that begin at the surface and continue down to bedrock, each kind of soil having its own particular arrangement. There are generally three main horizons (in which soil scientists recognize many subdivisions). The topmost layer consists usually of dark topsoil, a mixture of plant roots and heaps of decaying matter, rich in humus, moist and feeling like bread crumbs in the hand. Beneath this is the subsoil horizon, usually containing small pebbles and stones; it is drier and usually lighter in color and penetrated by fewer roots; it is also gritty to the touch. The lowermost horizon is composed primarily of the splintered chunks of rock that underlie the true soil.

Almost all Temperate Zone soils possess these horizons, but they differ widely, depending on the climate and the kind of underlying rocks from which they were ultimately created. In a trip around the United States the observer may see various kinds of soil along road banks or railroad cuts—the gray soils of the desert sagebrush country of Wyoming, the gray-brown soils of the eastern deciduous forests, the rich brown soils of the Pacific Northwest rain forests. In the tropics, the rain-forest soils will reveal themselves as bright red or orange.



Moles have powerful forelegs and shovel-like claws ideally constructed for tunneling galleries through the soil in endless quest of earthworms and insects. They cannot survive for longer than 12 hours without food.

amount of moisture they need, although some, such as black locust, grow well under many soil conditions, deep or shallow, moist or dry.

When peasants examined the soil of the Russian coniferous forest, they noted a deep layer just beneath the surface which was grayish in color and appeared to be composed of ashes left by forest fires. These soils came to be known as "podzol," the Russian word for "ashes." The ashy layer is not the result of fires, but has a much more complicated history. The needles on the floor of evergreen forests decay slowly, largely because of low bacteria

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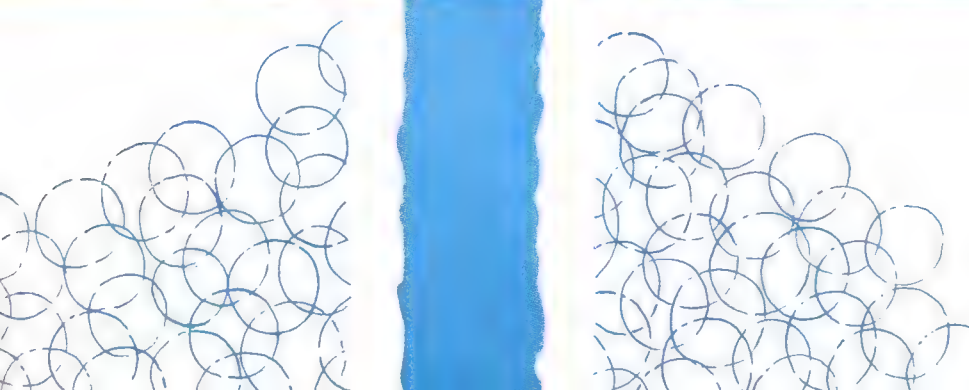


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Detergents should foam in the sink but not in the sewage. Allow rivers to foam with detergents and there is the hazard of water pollution and sewage disposal interference. These have become serious problems in many countries.

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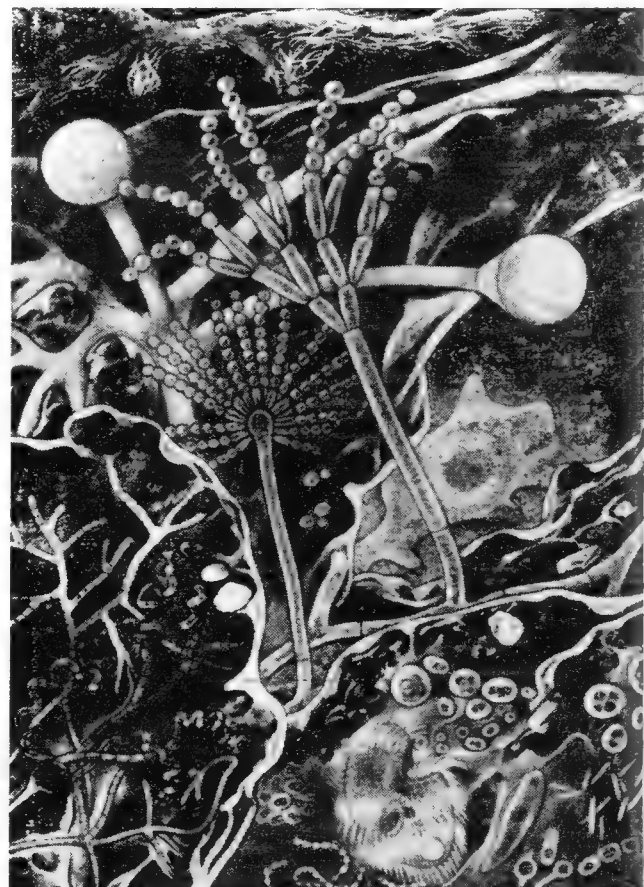


SOIL CONTINUED

populations and the absence of earthworms, and thus form a tight heap of undecayed matter. When this layer is attacked by fungi, a chemical reaction takes place that results in the production of acids, which the rains wash downward, carrying away with them large amounts of the minerals in the subsoil. Thus the topmost soil horizon in a coniferous forest usually consists of a mass of plant materials in various stages of decomposition on the surface, underlain by a sterile layer, acidic and lacking in minerals—the “ashes”—in which few tree roots can grow. These are the true podzol soils that are found throughout the north woods and on wet mountainsides, as well as in many of the pine lands in the southern states of the U.S.

There are some deciduous forests, composed almost exclusively of oaks, that have a similar soil. The tough, leathery oak leaves cover the ground with a thick layer that is not easily blended with the mineral soil. That is because oak leaves contain a high proportion of tannin, the same material that is used to toughen and preserve leather. This makes them resistant to decay by microbes and apparently unpalatable to earthworms. Thus the leaves accumulate over long periods of time, often stifling the undergrowth almost completely.

Where many other kinds of deciduous trees grow along with oaks, the forest soil can become deep and rich, the decomposed litter mingling with the mineral grains so that there is a gradual transition from the freshly fallen litter on the surface to soil with large amounts of humus beneath. Earthworms are usually credited with creating this type of soil—“mull”—for it is in the mixed deciduous forests that they find their favored kinds of leaves and preferred soil conditions. This type of forest soil when cleared is productive of crops, for it is loose and porous for the entrance of water. It is the home of some of the most attractive woodland flowers—jack-in-the-pulpit, anemone, bloodroot and Dutchman’s breeches. Each year it is replenished by the addition of minerals and organic matter from the rain of leaves and branches. They are immediately attacked by the billions of soil organisms—which insures the leafing out of another spring.



Agents of decay in the forest are the fungi and other soil organisms. White fungus filaments interlace with strands of moldlike actinomycetes (lower left) and with bacteria, protozoans and algae (lower right).



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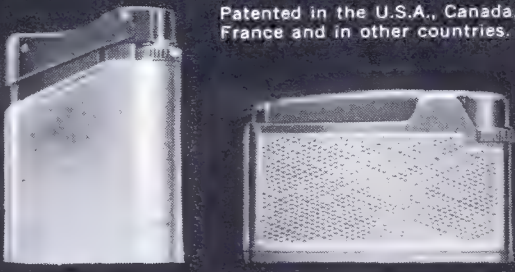
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PIA mechanics could service 937 cars in the time they take to check one big jet properly

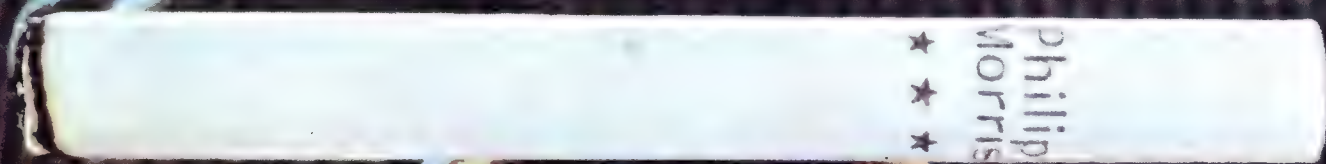
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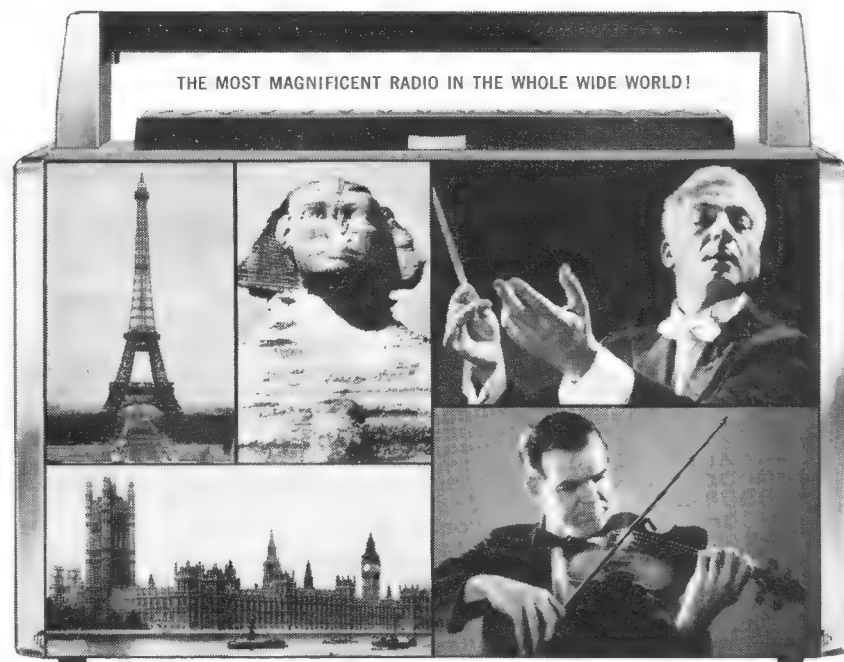


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Beech that would grow upright in better environment is twisted and stunted by gales of South America's Tierra del Fuego.

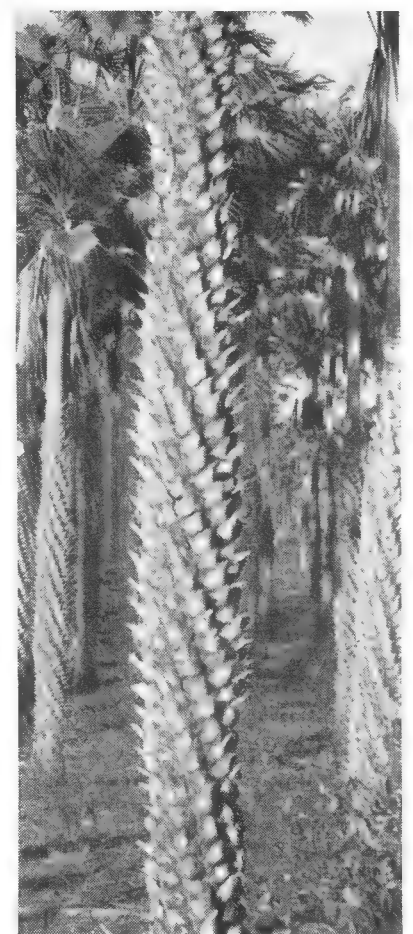
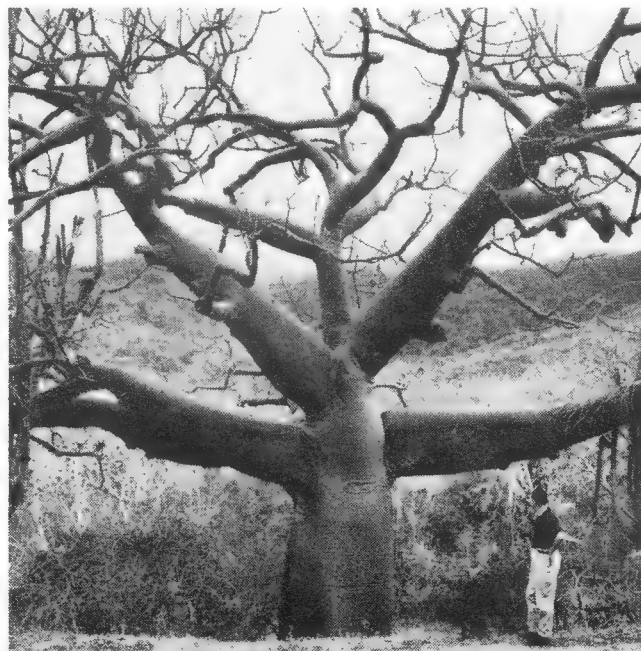
Odd shapes found in the forest



Trunk of *Acrocomia* palm holds food.

So many and varied are the forms of tree trunks that one sometimes wonders if the thing is a tree at all. Yet each trunk has its purpose, or reason, whether it be a bulbous reservoir for food, as in the case of the *Acrocomia* (left), or the effects of wind and weather, as with the storm-worn beech of Tierra del Fuego (above). Although the prime purpose of a trunk is to lift the leaf-bearing limbs into the light, some tropical trees bear their leaves right on the trunk as does the Brazilian wax palm (right), whose trunk is studded with the thornlike bases of old leaves.

Squat trunk of a cultivated kapok tree supports enormous branches. In the competitive rain forest, it would grow taller.



Brazilian palm has a bristling trunk.

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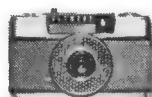
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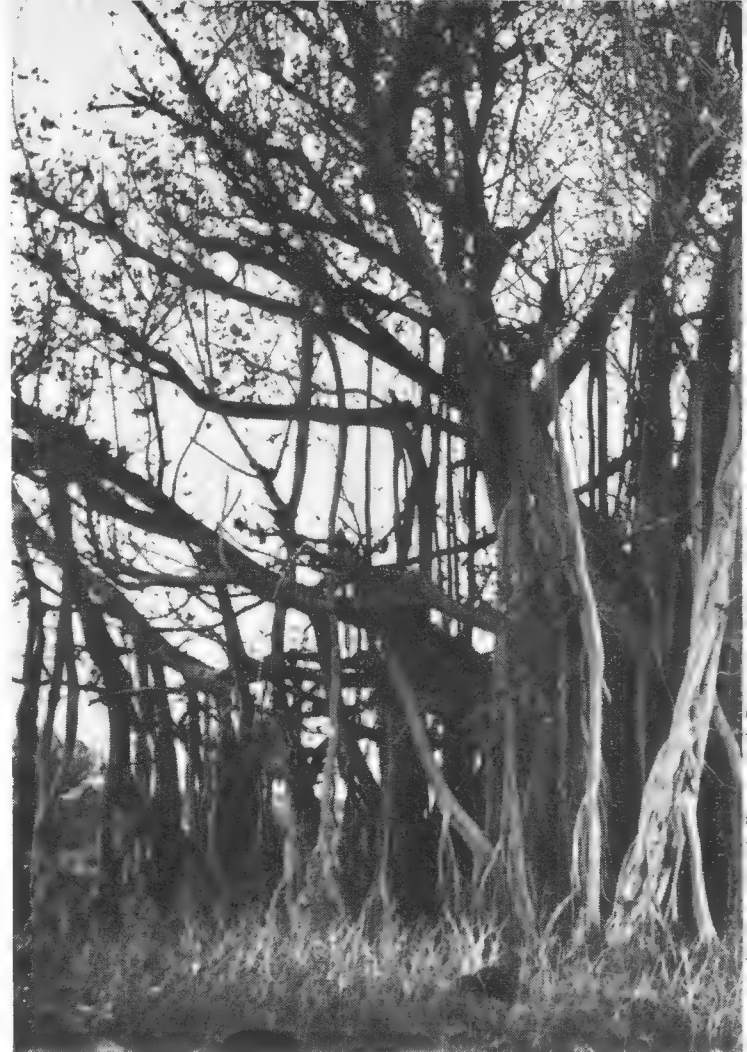


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The banyan tree has more than a hundred descending roots which an-

The weird ways

The roots of trees are often as oddly shaped as the trunks. But even stranger are the variety of weird ways in which roots carry on their dual role of anchoring the tree and providing it with nourishment. Some function in water, some even high in the air. The pandanus (*right*) sends out a cluster of stilt roots which curve protectively around the young tree and help support it. Others, like those of the fig tree (*below*) and the banyan (*above*), begin life as totally untreetlike plants high on a branch of a host tree. In the course of their development into trees, they send down many roots which take hold in the soil, grow thick and strong and ultimately kill the host on which they first grew.



A strangler fig encloses a host tree with mighty buttress roots. Soon the powerful roots will choke the host to death.



chor in the soil and make it look like a grove of trees. But this is a single tree.

of tree roots



The stilt roots of the pandanus, or screw pine, serve as props for the top-heavy tree and help it weather violent storms.

CONTINUED

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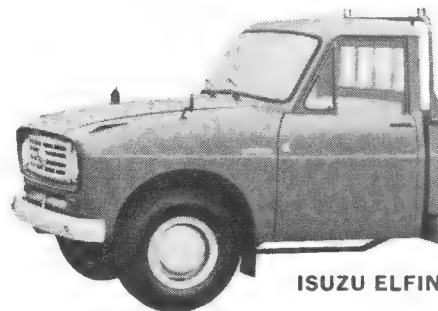
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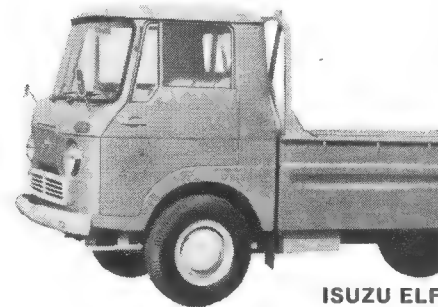
The ISUZU BELLEL is a luxurious 6-passenger car of optimum size. It offers fully upholstered seats and superb riding comfort. ISUZU engineering assures dependable performance. The BELLEL offers you a choice of a 55-HP diesel, 72-HP, 85-HP or 95-HP gasoline engine.



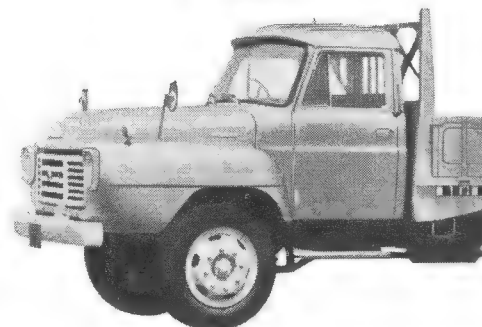
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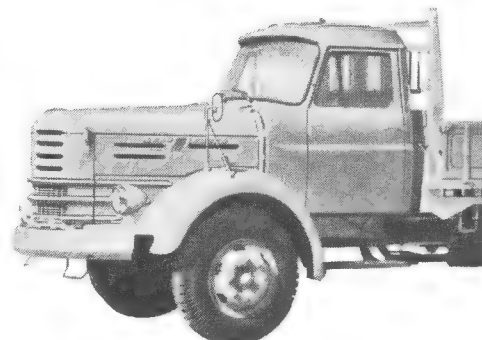
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ISUZU 6-TON TRUCK

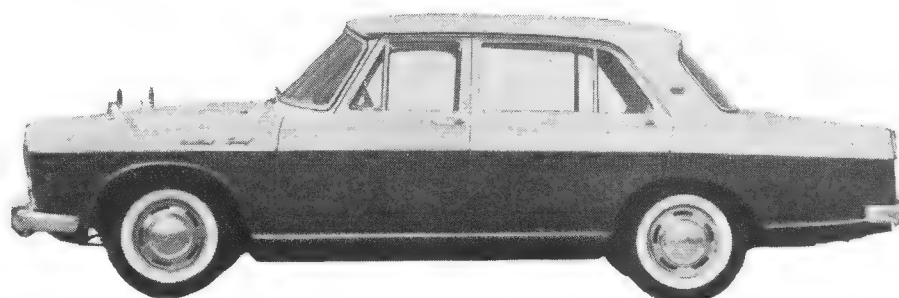


ISUZU 8-TON TRUCK



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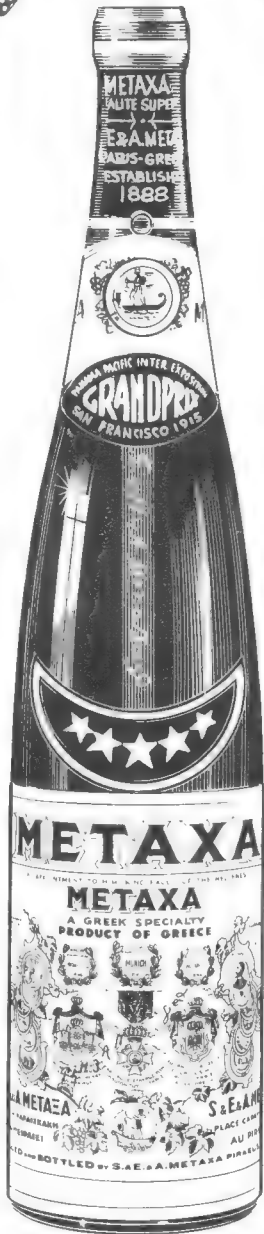
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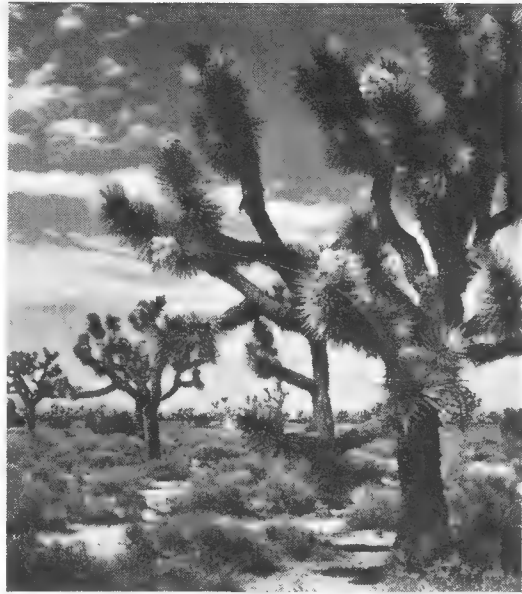
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Joshua "trees" twist their bristly clubbed limbs on a California desert. They were named by Mormons because they resembled beckoning prophets.

Some trees that aren't

Some "trees" in tropical climates are in reality only masqueraders in tree form: flowers, ferns and grasses that have taken on great heights and treelike shapes. But in temperate climates, closely related species occur only as small ground herbs. The 40-foot Joshua trees, or yuccas (*above*), are actually lilies. Like the 50-foot ferns (*right*), they have no solid wood in their tough, fibrous trunks. The giant bamboos, below, though treelike in size, lack not only solidity and the growth layers of trees but they are hollow like most members of the common grass family, to which they belong.

These bamboo stalks in China (*below*) are gigantic. But there are almost 700 kinds—some only inches high, some that grow three feet in 24 hours.





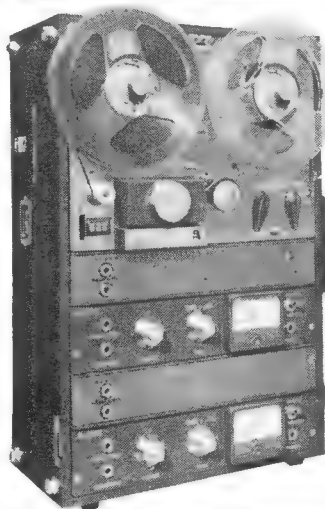
Tree ferns flourish on rainy, tropical mountains like this volcanic height in Java. The name is misleading, for they are simply larger and sturdier types of the well-known forest fern.

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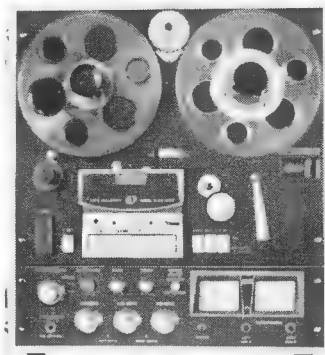
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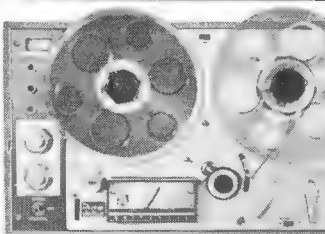
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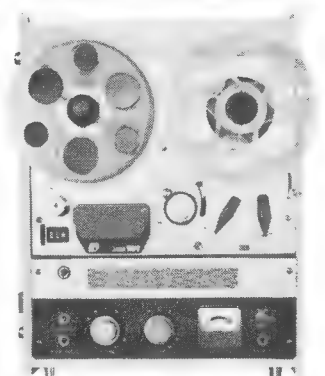
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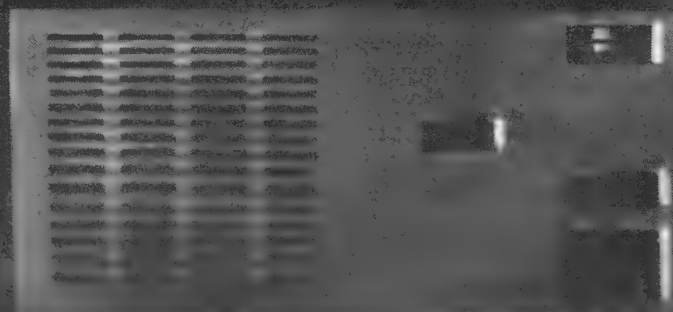
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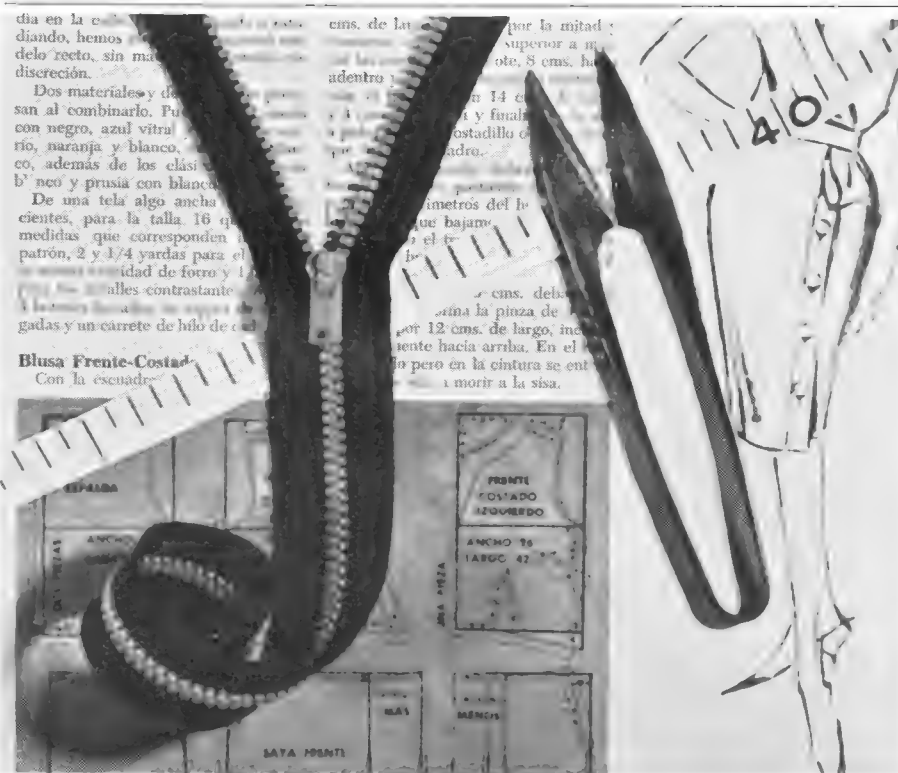
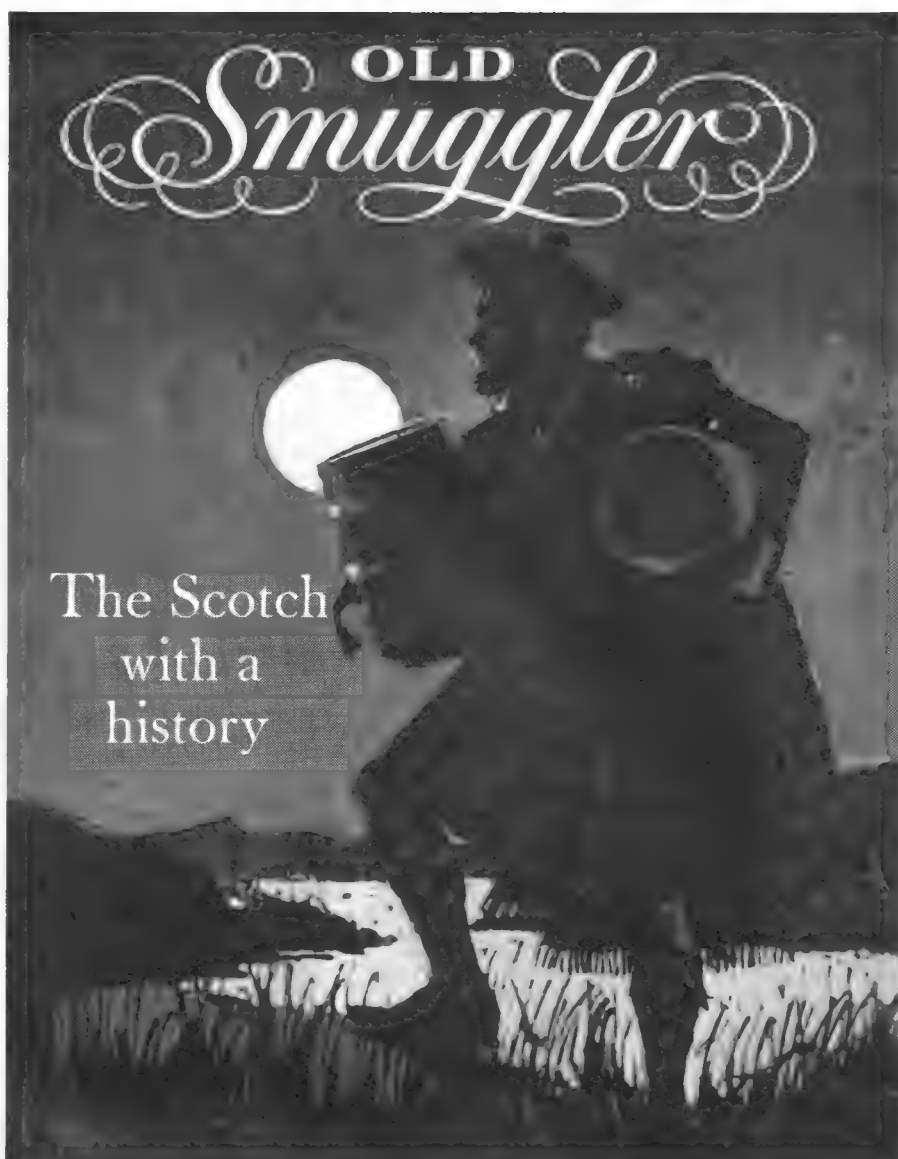
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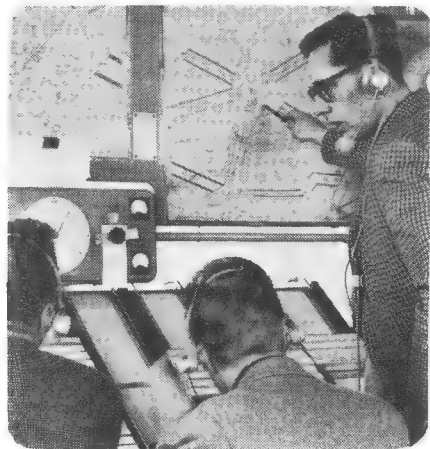


experts who judge wines three times each year - just for KLM!

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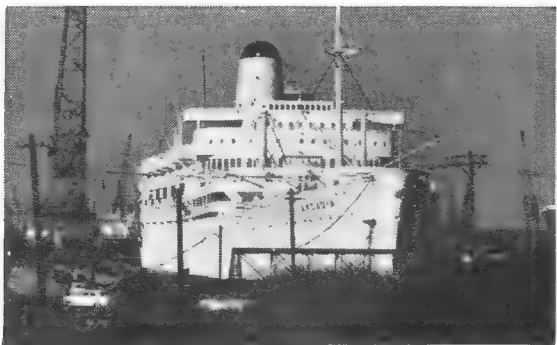
By the time your jet is ready to cross the Atlantic, it has been

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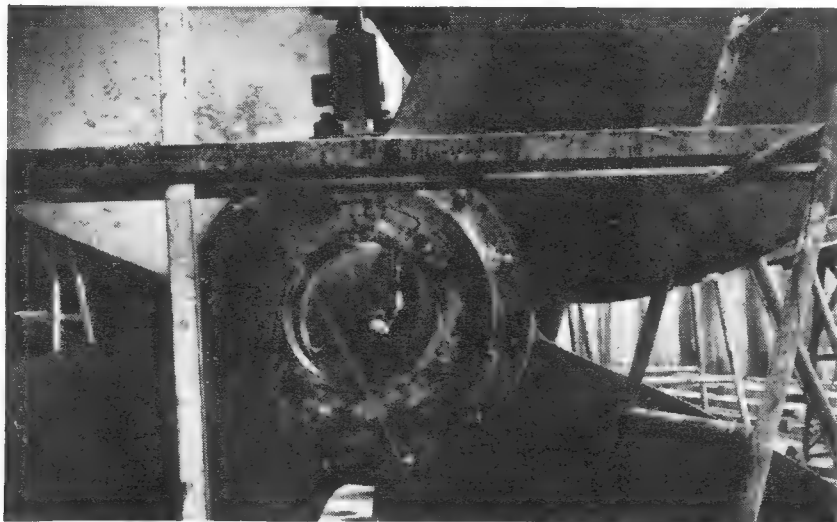
**Ship out
of water**



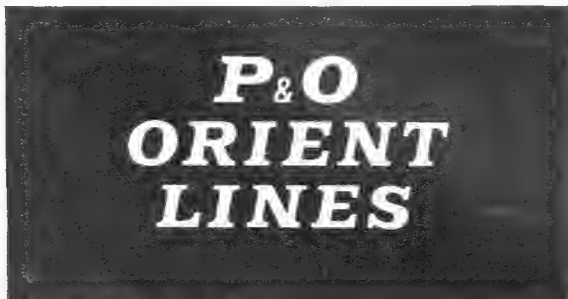


On average every seven months, every P&O-Orient Liner goes into Dry Dock. It's a rigorous programme. Even as the water is being drained from the Dock, men on pontoons, moored alongside, wash down the hull with long-handled brooms. As the water level drops, so the men wash far below the water line. In the Dry Dock, the ship stands on blocks, towering above the men who go to work, examining the hull, removing the propellers, checking the stabilisers. Officials, whose job it is to check the ship in sections, move in. A dent perhaps, a minute dent in this enormous hull, must be repaired – if it isn't the ship may not be passed as seaworthy. Outside men work day and night. Inside, the same. From refrigeration plants to boilers, everything is checked. Lifeboats are examined, fresh water tanks are emptied and cleaned, carpets are repaired, chairs are renewed, even ashtrays come in for examination. Regular Dry Docking ensures a fleet of smooth running ships. It's yet another example of how P&O-Orient Lines make sure of providing the best service, all the time

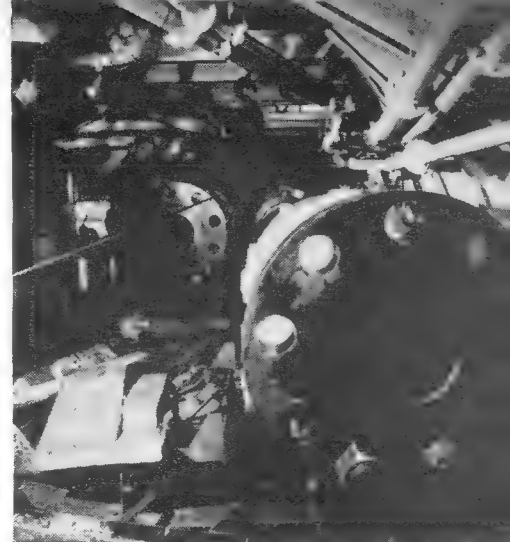
RUSTPROOF ARTIST Above him 30,000 tons of ship, by his side a gallon of anti-corrosive paint. This man searches for rust patches on the ship's hull and makes them good.



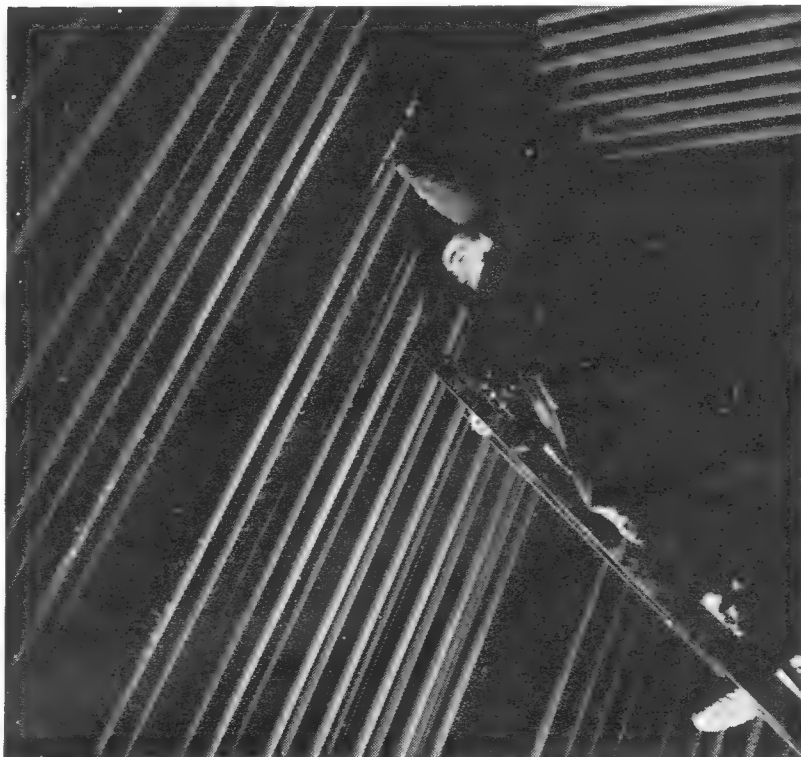
PROP FOR A PROP A giant propeller stands in its wooden prop on the Dock floor. Together with its Port Side partner this propeller churned up over 155,000 miles last year.



CRACKSMAN With hammer in hand, an Inspector examines the anchor by tapping it. Ranged out on the floor of the Dock, this chain stretches for a quarter of a mile.



'EAVE EASY!' A vital direction shouted to a winch operator, as in the bowels of the ship the starboard propeller shaft is drawn from the stern tube.



HOTHOUSE Inside one of the Watertube Boilers of the ship, a man renews a tube. His job is quite a cool one, but before the week is out this boiler will produce 165,000 lbs of steam at 530 lbs per square inch.



GO ASTERN the propeller shaft has been drawn and the propeller hoisted clear. With the shaft withdrawn, wood-joiners crawl in to renew the lignum vitae packing.

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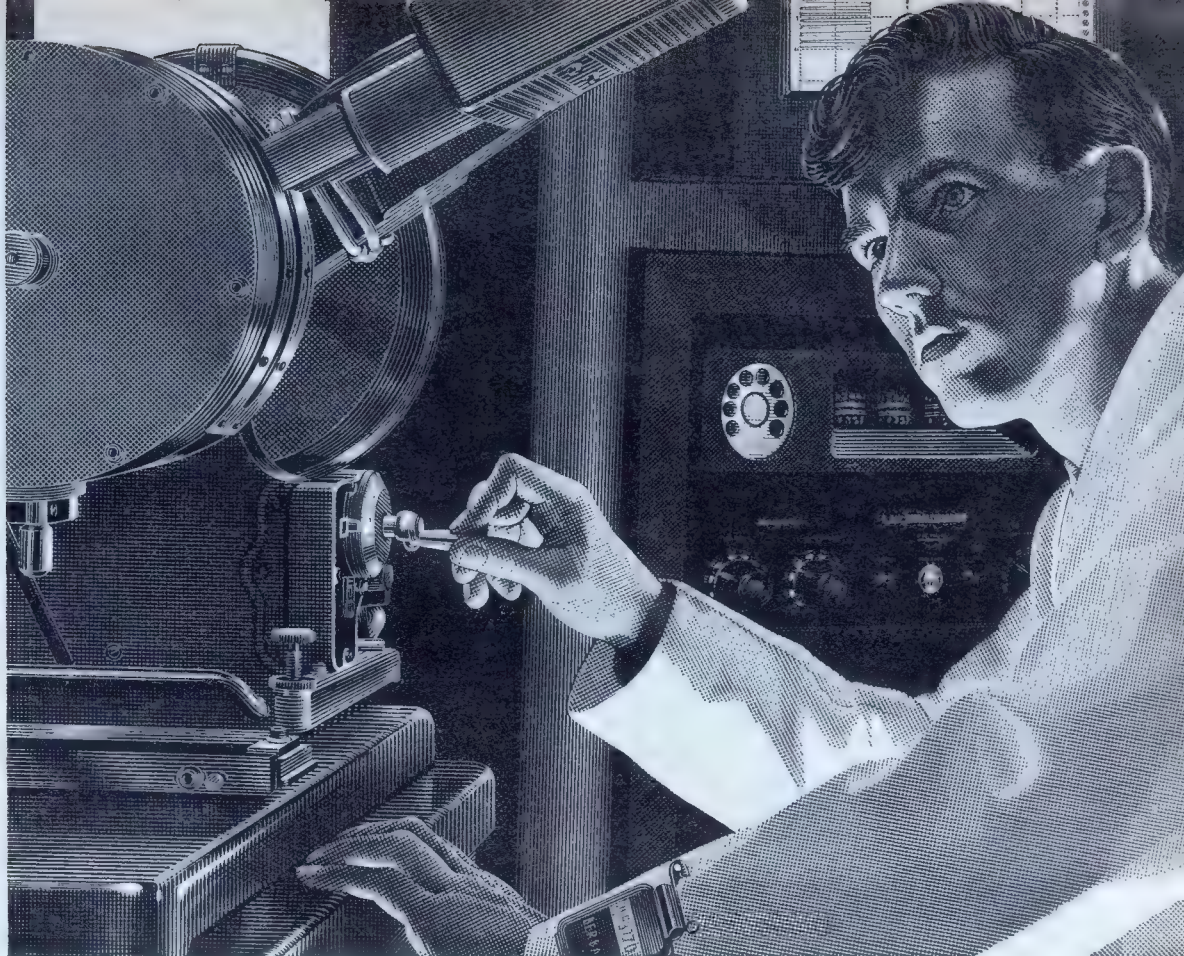
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RESEARCH

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NEW PASTURES FOR OLD

Thousands of acres of British farmland grow nothing but coarse grasses and weeds that provide little or no nourishment for cattle or sheep. These useless, often unploughable, pastures can now be made productive, through paraquat, the latest discovery of I.C.I.'s agricultural scientists. Paraquat, which is being marketed under the name of 'Gramoxone' W, makes it possible to reseed these pastures without ploughing them up. It destroys the old, useless sward and, because it ceases to be active the moment it touches the ground, the soil can be reseeded almost at once with rich, lush grasses. The result is new pastures that will play their full part in producing meat and milk for the nation. This latest I.C.I. discovery will have as big an effect on grassland farming as did the earlier I.C.I. discovery of 'Agroxone', the first of all selective weedkillers.

In the course of every year the work of I.C.I.'s 10,000 research and development workers has an impact, great or small, on almost every kind of human activity. The more spectacular achievements catch the popular imagination and become a part of chemical history. But no less important in aggregate are the numberless small contributions of I.C.I. research and development, which are daily paving the way to greater efficiency in other fields.

Here are three examples :



AID TO TROPICAL MEDICINE

There are ten million sufferers from leprosy in the world today, despite the fact that the search for a cure has been pursued since Biblical times. An I.C.I. discovery, 'Etisul', offers new hope in the attack on this disease. The great advantage of this drug, besides its efficacy, is simplicity of treatment, which greatly appeals to the patient: it is simply applied to the skin, and from there it is absorbed into the system. After two or three months the patient, though not yet fully cured, is non-infectious, and can mingle once more with his family.



WALLPAPERS THAT REALLY WASH

Out of I.C.I. laboratories has recently come a new P.V.C.-coated wallpaper, 'Vymura', that sets a new standard of durability and cleanability in wall coverings. The material has proved that it can withstand scrubbing twice weekly for 12 months, without detriment to its beautiful designs. Ink stains, beetroot and tomato juice, and cooking fats are completely removed from 'Vymura' by soap and water.

I.C.I.'s far-ranging research
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to progress in many fields

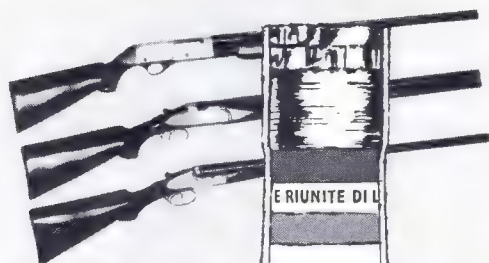
IMPERIAL CHEMICAL INDUSTRIES LIMITED, LONDON, ENGLAND



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Add to the list of fine Italian delights the liquid gold of Galliano, the legendary liqueur, "distilled from the rays of the sun." There's no taste quite like it. Try a sip of its bright, sunny flavor. Galliano—the superb Italian liqueur.



Monarchs of the forest

The world's most massive living things are California's giant sequoias (*left*), found on the western slopes of the Sierra Nevadas at altitudes from 4,500 to 8,000 feet. They do not grow as tall as another type of sequoia, the coast redwoods (*right*), shown shimmering in cathedral-like splendor at Prairie Creek Redwoods State Park in California. The redwood sequoia, which inhabits foggy areas near the sea, grows up to 364 feet tall, sometimes has trunks 20 feet in diameter—large enough for roads to be cut through them. But the trunks of the giant sequoias are much thicker and their total bulk greater. For example, the General Grant tree at left contains sufficient wood to build a village of 50 six-room houses.

Sequoias live upward of 3,000 years and, next to the bristlecone pines, are among the oldest of living things. Their longevity is largely due to the extraordinary qualities of sequoia bark. It is too thick (sometimes up to two feet) and too highly impregnated with tannin to be vulnerable to any known species of insect. Spongy and fibrous, it is nearly as fireproof as asbestos. The top of one sequoia, struck by lightning a few years ago during a July thunderstorm, smoldered quietly, without apparently damaging the tree, until it was put out by a snowstorm in October. About the only things that can threaten a mature sequoia are climate change, earthquakes and soil erosion. These latter two causes might upset the balance of the tree and cause it to topple. But even this is unlikely; a sequoia's great flat mat of roots covers three or four acres. A giant sequoia may begin to bear seeds at 70 years of age, but it is not usually mature until it is 300 or more years old. Then it rains down millions of tiny seeds roughly the size of a pinhead. What with the heavy shade cast by their gigantic parent and the matted roots beneath them, these seeds have little chance of maturing. Experts have rated the odds against each seed at about a billion to one. Nevertheless, the trees are well able to reproduce themselves if left alone by man. They were heavily logged in years past. Their wood was found to be attractive, a salmon-pink color when first cut, turning to a dark maroon when it weathers. Furthermore, like the bark, the wood of the sequoias is remarkably durable. Fallen trees may lie on the ground for hundreds of years and not show any signs of decay, and the wood burns very slowly since it contains practically no pitch. However, loggers soon found their huge size made the sequoias difficult to transport and, while durable in one way, the wood was brittle and had a tendency to smash when the tree was felled. Now the sequoia is protected and on the increase.





THE DESERTS

*Their vast, arid and awesome
areas test man's abilities
and promise vast resources*



The brown, lavalike earth of the Atacama (*above*) is so rich in nitrates that no plants grow for hundreds of square miles.

The deserts are awesome areas of the earth. They are stark and beautiful; they move man to ponder the power and majesty of the land; and they tax his ability to stay alive. The desert can be ferociously hot (the highest temperature ever recorded was 136.4 degrees F. in the shade in the Libyan sector of the Sahara) and cruelly arid (Chile's barren Atacama Desert, shown above, never receives more than .04 inch of rain a year). Dry winds in the Sahara, moaning and hissing through desert sands, build up golden dunes, some many miles long and over 500 feet high. And occasionally, as the sands slide, the dunes boom (so the old legends describe it) like the eerie tolling of bells underground in a sand-drowned monastery.

One of every seven square miles of earth consists of desert. Deserts sprawl about the world in two narrow, unconnected belts which straddle the Tropic of Cancer and the Tropic of Capricorn. In the belt north of the Equator is the Sahara (monarch of them all), plus the Arabian (sandiest), the Iranian, Turkistan, Takla Makan, Gobi (coldest) and North American deserts. In the belt south of the Equator are the Atacama (world's smallest) and Patagonian deserts of South America, the Namib and Kalahari in South Africa and the Australian desert (the world's second largest). Locked away in them all are the last great untapped regions of fertile land on this crowded earth. And the key to the lock is water.



In the Ahaggar Massif, a volcanic highland that rises to 10,000 feet in the Algerian Sahara, powerful winds and flying sand have carved the jutting rocks into the grotesque pinnacles marching into the distance in the picture above. Even in this wasteland, nomadic tribes somehow manage to raise livestock.



In the course of their blind task of diminishing continents, the forces of erosion often mold the landscape into weird but strangely beautiful shapes like the ones above in Arizona's Monument Valley. Caps of hard rock enable

these jagged monoliths of red sandstone to resist the rains that have worn down the surrounding cliffs. The height of the serried columns—sometimes over 500 feet—indicates how far process of erosion has lowered desert floor.

They often take wondrous shapes

The desert is far from being a flat, monotonous expanse of sand. Water and wind pick up the tiny grains of sand and hurl them about to produce the wondrous whigmaleeries shown on these and the next two pages. The sand, mostly made of quartz, grinds down to round, smooth particles as small as five-hundredths of an inch in diameter. They bounce off one another without damage to themselves and last millions of years. Aside from water, no better tool can be found for carving down a mountain or twisting it into forms straight out of a monster's nightmare.

There are still many flat deserts on the land. Libya's great Selima sand sheet, a thin coat of sand over bedrock, stretches for 3,000 square miles with barely a rise or a dune. But even flat deserts are not monotonous. Most are blazing hot; the Gobi can be bitterly cold. While most are sun-blasted, a part of the Atacama is fog-shrouded. The Sahara has everything: 11,000-foot mountains that get snow, a lake as big as Wales and oases that shelter three million people. The only common factor is dryness; a desert is anywhere that gets less than ten inches of rain a year.



Wind-sheared brush in California is living proof of the desert wind's power. The shrubs have been cropped by wind to fit the shape of the sheltering rock.



Wind-blown sand carves hard sandstone and erodes softer rock underneath in Utah's Goblin Valley. Elongated shapes are aligned with prevailing winds.



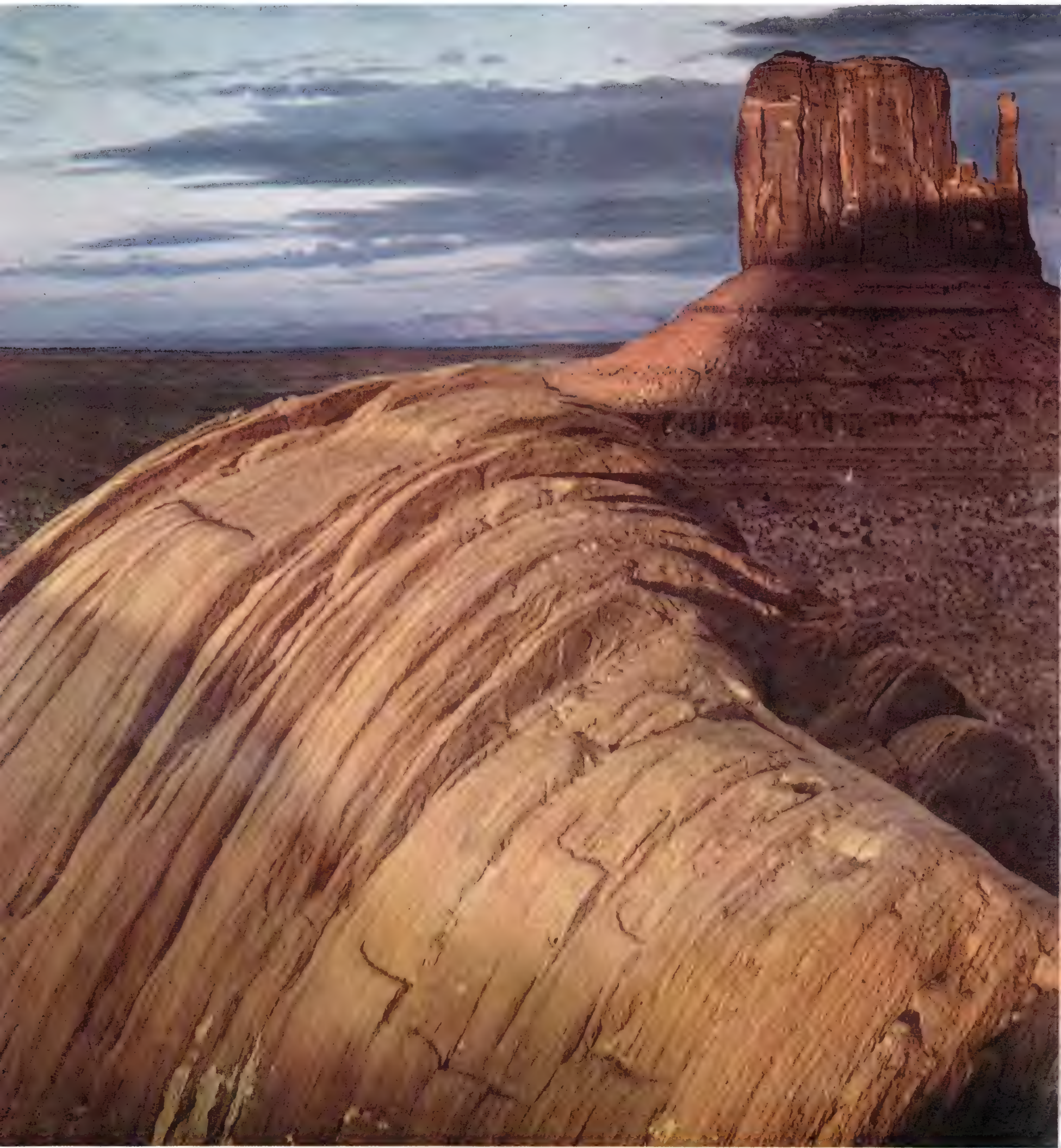
Sand-smoothed arch in southeastern Utah was shaped by grinding winds widening a tunnel first bored by a stream of rain water through the huge stone.

Arches, pedestals,



Glowing buttes in the U.S. Southwest dominate the skyline at sunset. One of the region's main tourist attractions, they are the work of water and the

bushes and buttes sculptured by nature



winds which cowhands claim can wear away the pine boards of a fence in just a few years. Some 70 years ago, two prospectors allegedly found a fabulously

rich silver mine in this dramatic land but they died before revealing their secret. In recent years, this colorful region has been location for many movies.



Eclipses, illusions and dust-ups

Storms in the desert are seldom wet. With rising winds the fine light desert floor dust is lifted first. It spirals thousands of feet into the air in clouds so thick that they blot out the sun. The same wind that will pull sand only a few feet off the desert will send dust across continents. The abrasive sandblast effect of the heavy cutting particles is strongest close to the ground. It is powerful enough to carve rocks into top-heavy shapes and to amputate

telephone poles at their bases unless they are sheathed in metal. But above 18 inches it loses most of its force. When the dust blows away, the sand remains as a thick cloud gliding slowly over the desert. In the clear air above it the heads of people and ostriches can be seen moving about as if they were walking chin deep in water. Often when the wind finally dies, only the base floor remains—a tight mosaic of smooth, hard, high-polished rock.



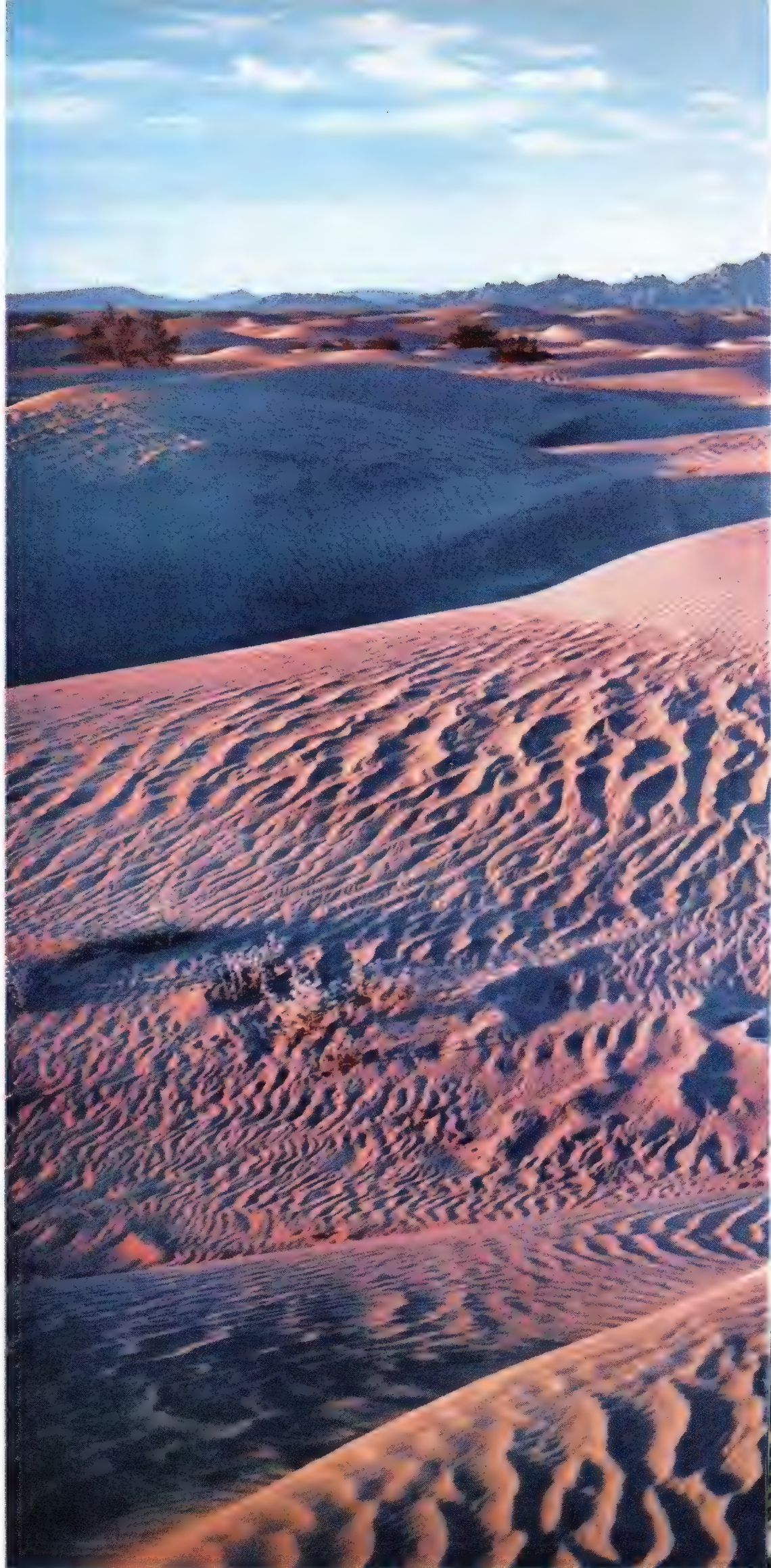
Deserts are always full of tricks. The same lucent atmosphere that helped to produce the spectacular picture of an annular eclipse shown at left may also warm in different layers of density on a

hot and windless day, creating such a mirage as the tantalizing illusion of a Saharan "sea" with mountains in it shown above. And when the wind rises (*below*) the donkeys can only drift with it.

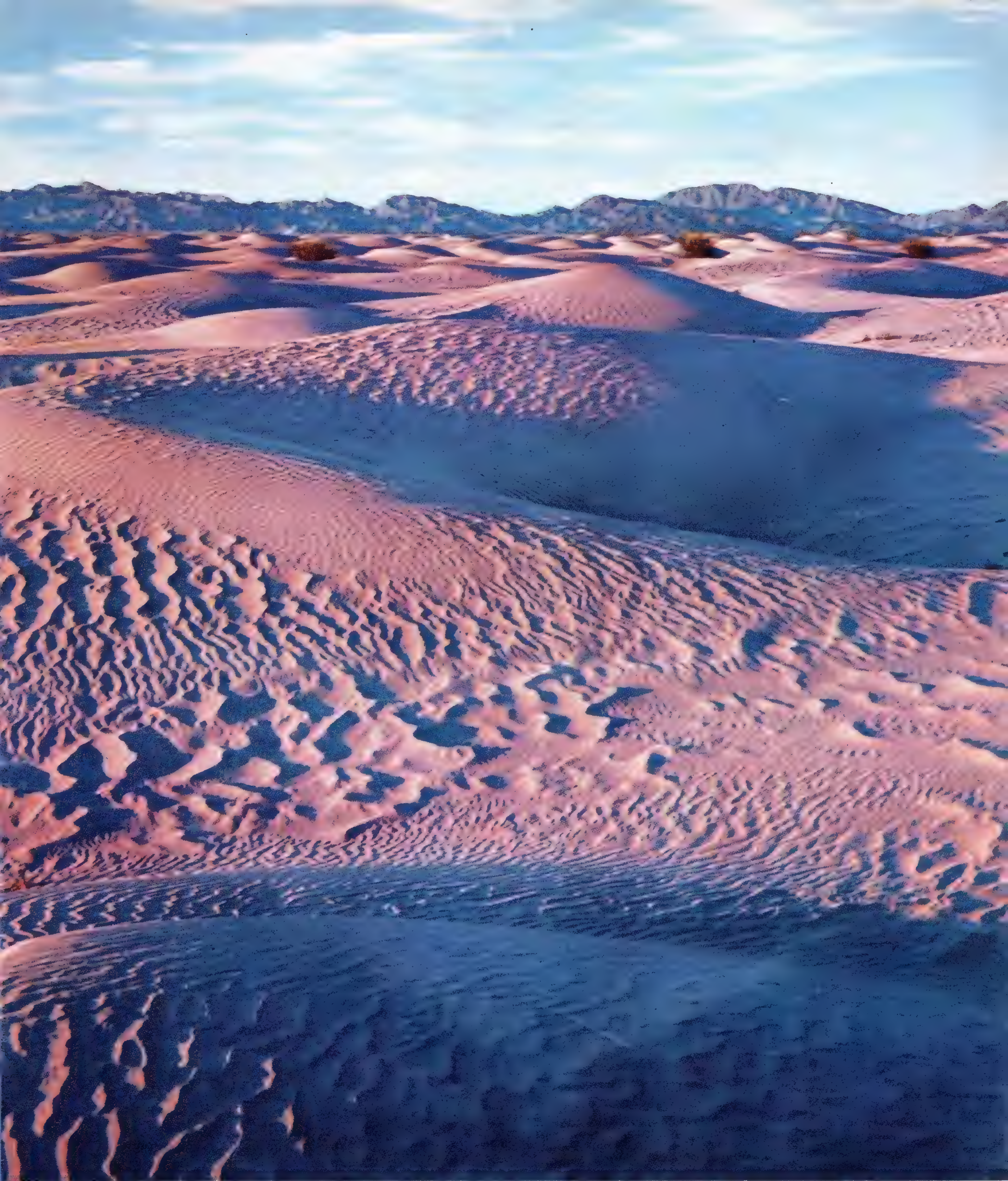


The allure of the dunes

There is a quality of implacability about dunes that fascinates the minds of men. They are great moving masses of sand. In the huge "Empty Quarter" of Saudi Arabia and in southern Iran they grow into 700-foot monsters 100 miles long and thousands of years old. These, although in theory still mobile, are for practical purposes fixed, permanent landmarks in the seas of shifting sand. But elsewhere they form as crescents or swords, sometimes in linked chains two hundred miles long marching up hill and down dale over the floor of the desert as long as the winds and the sand supplies are maintained. Examining them, from the movement of a single grain of sand to that of a 100-mile-long monster, the British physicist Ralph A. Bagnold tried to explain their allure. "Instead of finding chaos and disorder," he wrote, "the observer never fails to be amazed at a simplicity of form, an exactitude of repetition and a geometric order unknown in nature on a scale larger than that of crystalline structure. In places vast accumulations of sand weighing millions of tons move inexorably, in regular formation, over the surface of the country, growing, retaining their shape, even breeding, in a manner which, by its grotesque imitation of life, is vaguely disturbing to an imaginative mind."



Sand dunes roll over the Sonoran Desert in Mexico like endless ocean waves sweeping to the remote horizons. They are crescent-shaped dunes called barchans and they show that the prevailing wind



in this area is blowing from the lower-left-hand corner of the picture up the long back slopes and over the sharp cliffs toward the upper-right-hand corner. They form the classic conception of what a desert

should look like, and they seem to lack only a patrol of the French camel corps rolling dramatically across the foreground. Yet sand dunes like these form less than 10% of all the world's desert regions.



A violent summer thunderstorm lashes at the cactus plains of the Arizona desert. Water floods down in nearly solid sheets and hailstones bombard the land. Such storms brew mainly in midsummer months when low-pressure

areas form over the desert in consequence of the intense heat of the land. Into these areas comes the cold, moist air from the Gulf of Mexico. Heated by radiation from the burning earth, the air is sent spiraling upward into gigantic

Rush of rain to arid land



A towering column of rain descending from a thunderhead in the distance is a welcome sight in the desert. The storm's violence may bring damage, but the water will put blossoms on the ocotillo plants in the foreground.

The essence of deserts is that they are dry and sun-scorched; but rains do come. They come too seldom and when they arrive they are often violent and even frivolous, but they come. Clouds wheel and sweep around mountains that usually block them out, air flows into barometric lows and the thunderheads build up. Then clouds burst over the barren country and pour out precious raindrops which sometimes do not even reach the thirsty ground. On a very hot day the rate of evaporation is so high that the rain often dries up and vanishes on the way down. Or, on another day, the rain may punish the earth with the destructive fury of the storm shown in the picture above.

In deserts water is primarily accidental and capricious, for the less total rainfall an area receives the more variable are its rains at any particular spot. In deserts the rain may fall on one side of a basin and not on the other. Tucson, Arizona, in theory, receives 10.9 inches of rain a year; in fact it records yearly totals ranging from 5.55 to 24.2 inches in the past 50 years; similarly, in theory the Sahara Desert has an average five inches of rain a year; but one Saharan outpost, Dakhla, has gone without a drop of rain for 11 years.

Thus some desert animals live out their days without ever experiencing rain. Or when it does come, it may come in tremendous fury and wash their lives away. But even as men dig wells and seek ways to use the dew, these sudden, unpredictable, apocalyptic storms remain the major source of the water that is the basis of all life on the deserts of the world.



thunderheads that explode in furious paroxysms of thunder and lightning. In a matter of moments the storm can deliver to a small section of the desert all the water it will receive for a year. And a few hours later all that is left

will be drying mud cracking in the sun. In that short time the rushing water can destroy roads, bridges and campsites; one such storm in the Mojave Desert carried off a railroad locomotive and dumped it in the mud a mile away.



Directly after the rain, streams of turbulent, mud-filled water rampage over the land, savagely killing much plant and animal life. The water will form short-lived, shallow lakes and "beaches" and then vanish into the ground.



The same spot as at the left is seen just one day later. The water has virtually vanished. The land, save for a few patches of still-damp mud hardening in the desert heat, is almost as dry as it was before the sudden storm.



When rain finally falls in the desert, even after years of drought, the desert blooms. Dandelions form golden fields under Mojave Desert buttes (*above*) and areas arid and sere are carpeted in color. Seeds long dormant in the dust

now mature, flower and produce new seeds in just a few weeks. But even when water and climate conditions promise good growth, some seeds remain dormant as a sort of reserve bank of seeds in case the first sprouts should fail.



Sand verbenas, blooming in the Borrego Desert of Southern California (above), are part of a pattern of puzzlement. Scientists have come to think that each seed may have a built-in, water-soluble trigger that tells it exactly

when to grow. Among the blooms are creosote bushes standing carefully apart from one another. Their roots, in a fierce competition for survival, battle one another under the surface for every drop of the life-giving water.



Most conspicuous of all moving things on the desert in daylight are lizards. The horned lizard, though he looks fierce, is placid and only three inches long.



A hungry American kit fox waits for prey. Its form and habits are the same as those of the Sahara fox, including huge ears to locate far quarry in the desert night.

The deserts' teeming wild life



Though the dry deserts appear to be most inhospitable habitats for animals, they actually teem with widely varied life. American deserts alone support about 5,000 species of specially adapted insects, reptiles, mammals and birds. Animal life on the desert is—as everywhere—tightly interwoven and entirely dependent upon plant life for its sustenance. Some desert animals eat plant foods directly; some eat each other. But for desert dwellers, life is forever a feast or a famine—plenty when the desert explodes into luxuriant foliage after a brief, violent rainfall, never enough during the longer periods of drought when both food and water are scarce. Reptiles—lizards (*opposite page*), snakes (*right*) and tortoises—flourish on the deserts mainly because they have a food source in the abundant numbers of insects and seed-eating rodents like the kangaroo rat (*left*). The kit fox (*above*) gets much of its water by eating this curious creature which, however, may itself live a lifetime without drinking a drop of water.

A kangaroo rat leaps high to avoid a foe. Neither kangaroo nor rat, it is barely two inches high, with outsized hind legs, big feet, a tail triple its size and a scrappy nature.

The sidewinder rattlesnake (about 18 inches long) has evolved a unique way of crawling across desert sands. It loops its body sideways, leaving ladderlike furrows behind.







In California's San Joaquin Valley, a Delta-winged plowshare reclaims land. Once semiarid, the valley is now one of the richest U.S. farmlands.

How Man Is Using the Desert as a New Frontier

In the wrinkled old hills of the Holy Land south and west of the Dead Sea it rains two to four inches a year, and the roar of the rare torrents tumbling down along the wadis is the loudest noise in the Negev highlands. Two thousand years ago this was a province of the Nabataeans, an industrious, grain-growing people who tamed the waters with one of the most elaborate irrigation systems ever built. Improving on techniques thought up at least a thousand years earlier by the Phoenicians, they threw across the wadis low-check dams of rocks, each of which trapped and held a level plot of soil which became a tiny cultivated field. Sidehill ditches and retaining walls controlled the runoff from the hills, and dense shrubbery planted along the dams held the rocks in place and further slowed the water's descent. Cisterns carved out of the rock gathered enough water for the people and their cattle, but most of the scant rainfall went to the crops. Nabataean records tell of the yields: eight measures of barley and seven of wheat for each measure of seed sown.

Rome conquered the Nabataeans' capital in 106 A.D., but their economy survived until the Moslem conquest of the Byzantine Empire finally destroyed it around 700. For more than 12 centuries thereafter the Negev was utterly neglected. Torrents obliterated the untended irrigation works and the sheep, goats and camels of nomads kept the land bare of plants; erosion went on unchecked.

This miserable countryside, a desert if there ever was one, formed part of Israel's 7,815-square-mile legacy in the 1948 partition of Palestine. Today it is part of an experiment closely bound up with the future of mankind. In their destitute and denuded wasteland the Israelis have more than doubled, to over a million acres, the extent of

usable agricultural land. By developing wells and putting the limited surface waters to better use, they have irrigated 325,000 dry acres. And they are rebuilding and expanding the ancient waterworks of the Nabataean engineers. To make sure these improvements will last they are doing what their predecessors never did, planting the uplands to grasses and forest to protect the watershed from erosion. Their livestock are pastured on the hills, but in numbers controlled to prevent overgrazing, the curse of so many arid-land cultures. Already, the Middle East's newest nation is an exporter of farm produce. "The example of Israel," wrote the pioneer conservationist Walter C. Lowdermilk in *Scientific American*, "shows that the land can be reclaimed and that increase in the food supply can overtake the population increase that will double the world's population before the end of this century."

Irrigation is the most dramatic way—though a way full of pitfalls—to increase production in arid lands. The mineral richness of desert soils virtually assures good crop growth when water is supplied. Some of North America's most highly productive farmlands are the irrigated valleys of the Rio Grande and the Pecos in New Mexico and Texas, the Gila and Salt River Valleys in Arizona, and the San Joaquin, Sacramento and Imperial Valleys of California. The Columbia Basin project in eastern Washington and the Colorado-Big Thompson project, which carries water under the Rockies from the snowy watersheds on the west to semiarid southeastern Colorado on the east, are among man's boldest and biggest alterations of nature's drainage systems.

CONTINUED

In southern California, the muddy waters of the Colorado River are filtered in six desilting basins before being routed by a canal to irrigate once desolate Imperial Valley 80 miles away.



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DESERTS CONTINUED

Irrigation also plays a major role in the ambitious Mediterranean Development Project of the United Nations' Food and Agriculture Organization. For certain reclaimable areas, the project aims to reverse the deterioration into desert of a billion and a quarter acres in the region where Western civilization was born and bred. Egypt's Aswan High Dam will drown the temples and tombs along 300 miles of the Nile above the First Cataract, but will bring two and a half million acres into bloom. The Soviet Union's plans dwarf all others: it is damming the Don, the Volga, the Amu Darya and other mighty rivers with the ultimate aim of watering 70 million dry acres.

Desert irrigation, however, is a tricky business. If the water is allowed to stand and evaporate, it leaves behind the salts it has carried in solution, and actually draws to the surface and concentrates additional salts already in the soil. To prevent this, an irrigation system must provide for overflow and downstream drainage. For want of such drainage, three quarters of all the irrigated land in Iraq is now dangerously saline. On the Menemen Plain in Turkey an elaborate and costly irrigation system was completed in 1949, without provision for drainage. Much of the land it has served has turned so salty that nothing will grow.

Another hazard: a river tapped for irrigation may run dry if its watershed is denuded, but, even sooner, the dams impounding its water may fill up with silt. Nevertheless the water problem of the deserts, and of the world in general, already has been solved—for tomorrow. Development of processes for large-scale conversion of salt water to fresh has unlocked the one really inexhaustible resource, the water in the seas. At the beginning of the 1960s, salt water was running through a number of widely scattered saline-conversion plants at the rate of 20 million gallons a day, a fourth of this serving arid Kuwait, where oil and money are more plentiful than drinkable water. By the mid-1970s the flow may approach 100 billion gallons a day.

Only a fraction of the desert, however, lends itself to irrigation, but much of the rest can be grazed by livestock. Though the forage production is skimpy and highly variable from year to year, the pastoralists have never ceased to herd their livestock over most of the world's arid lands, with a persistence that attests the importance of domestic animals in human affairs. Failure to understand the insidious effects of overgrazing on desert vegetation has without question led to the collapse of more civilizations than all other factors together, including war, conquest and pestilence. It is difficult for man to see the seeds of his own undoing in a quiet pastoral scene of cattle or goats grazing contentedly on a hillside. For the early stages of overgrazing are not reflected in any loss of condition in the animals. An arid grassland or shrubland can continue producing fat



At Gassi Touil in the Sahara, the reservoir of natural gas is so large that when it caught fire, 30 million cubic feet a day burned until it was put out.

cattle, sheep or goats long after the vegetation has reached a critical stage, and it is only when the nutritive forage suddenly vanishes and merely weeds remain that the magnitude of the disaster is revealed. Then it is too late for easy remedial action. In more humid situations a ruined pasture can be restored with relative ease by the application of fertilizer and lime, as needed, and replanting with seed of desirable forage plants—usually grasses or legumes (like clover) or the two together. Per-acre yields are high enough to justify the cost. But on desert lands, forage yields are so uncertain and usually so low that the expense of artificial rehabilitation is forbidding and the returns are slow in coming in. Yet in the long run the restoration of arid ranges will be of tremendous benefit to mankind, and in fact it is essential to a good many nations owning mostly desert or semi-desert lands.

The most obvious riches of the arid lands, and the most coveted, are the deposits of oil and valuable minerals. Many of the world's greatest oil fields have been located in desert situations—Arabia and Iraq, the Sahara, western Texas, the southern San Joaquin Valley of California. And scattered about the deserts are some fabulously rich mines—silver in northern Mexico, copper in Nevada and the Atacama, uranium in Utah and New Mexico, diamonds in South Africa and so on. A certain class of minerals exists in the desert specifically *because* of the aridity; these are the water-soluble compounds such as salt, gypsum, borax, nitrates and phosphates. A billion dollars' worth of borax is being scooped out of the world's biggest deposit, in the Mojave, partly in order to extract a few pounds a day of the pure element boron for research on exotic rocket fuels and new plastics.

The native plants of deserts offer surface resources exploitable for much besides livestock forage. In the Soviet Union, for example, a large part of the synthetic rubber production is now obtained from two "dandelions" (*Scorzonera tau-saghyz* and *Taraxacum kok-saghyz*) which were found in the Tien Shan Mountains in 1930 and 1931. These wild plants are now widely cultivated, and the latex they produce makes Russia less dependent on world rubber markets. The guayule shrub of the North American deserts also produces rubber in commercial quantities. Many drought-hardy pasture and range grasses have been

derived from desert stocks, and so have a tremendous number of ornamental trees and shrubs, such as tamarisk from Arabia, genesta from Libya and Washington palm from the Mojave of California. Drugs, fibers, dyes, alcoholic liquors (tequila and mescal, from a century plant) and edible fruits are part of the desert's bounty.

The most exciting new development on the desert scene has to do not with man's discoveries of oil, nor even his rediscovery of the Negev, but his discovery on the North American desert of a new way of life.

For most of the four centuries since the Spaniards explored the deserts of the U.S. Southwest, men treated the region with extreme caution. Then, in World War II, the desert suddenly was made habitable. To the armed forces and the aircraft industry, it offered year-round dry, clear air and plenty of space for maneuvers and testing. They moved in, sank thousands of water wells and built tremendous factories, bases

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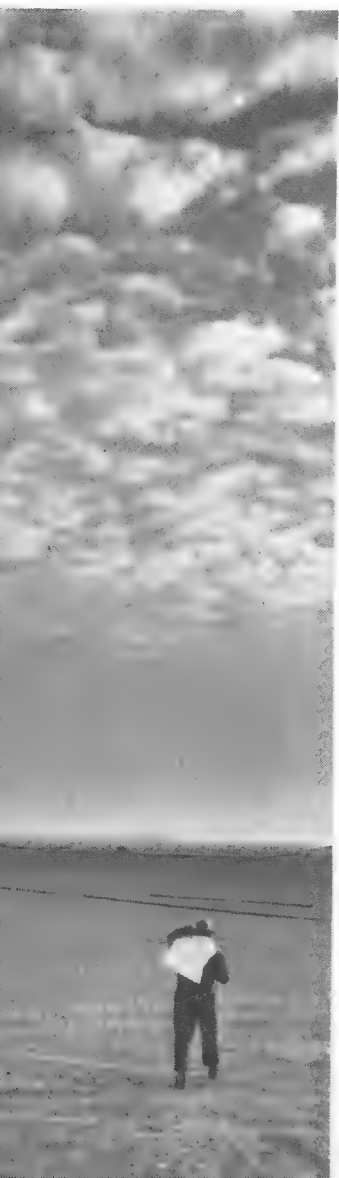


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DESERTS CONTINUED

and service facilities in the Mojave and Arizona deserts.

In the wartime and postwar migrations that brought millions of newcomers to the Far West, the tide of people surged into the big cities, then overflowed onto the deserts from Los Angeles on the west, from Phoenix and Tucson on the east, in search of elbowroom and fresh (preferably conditioned) air. Suburbs, and then brand-new cities, mushroomed out through the creosote bushes and the mesquite. The changing face of the desert reflected the great invasion. New cement plants, electronic plants, guided-missile plants rose on the plains. New wells and new irrigation ditches, lush farms and mass-produced swimming pools painted green patches on the brown earth.

In time, most of the desert will be used by man for one purpose or another—planting, grazing, mining, hunting, living or playgrounds—but inevitably scientists want and need to know what the original situation was, to understand the changes that have come about with use. For example, how valuable it would be to the agriculturalists of modern Israel if one part of the Negev had been preserved over the centuries free of grazing or use of any sort. What would the soils, the vegetation, the runoff of water, even the climate be? Would such a remnant indeed be a desert? Obviously it would not have occurred to the Nabataeans to set aside such a preserve, but the idea should occur to men today. Man has proved to be wrong so many times in what he assumed was good enough land management that he may easily go wrong again. An unmanipulated "check" is part of every scientific experiment. There should be checks as well to evaluate our massive experiments in land manipulation. Wilderness does have a scientific value.

As the world population spirals upward, there is a corollary increase in the value and the importance of every natural resource. Products of the earth that were not used or needed a century ago are being pressed into service today to meet the growing demands of people and of industry; and this trend will be accentuated. There are no longer any "waste" spaces on the earth. The Arctic tundra, the ocean depths, the craggy mountains and even outer space itself are all entering man's plans for his future. The deserts are a part of the world that was used only lightly (and in general unskillfully) by earlier men, but this cavalier treatment can no longer be afforded—there are too many of us now. In some nations where men are hungry, desert lands that once were used, spoiled and discarded are being laboriously brought back to productivity. In some newer countries the problem is less acute—for they are under no immediate threat of famine—but the desert resources nevertheless are being put to use, one by one, to yield food, fibers, minerals, living room—all things that men want and need. Up to now men have treated the deserts as if they made no difference. One of these days, when survival no longer can be taken for granted on a crowded, used-up earth, they may make all the difference.

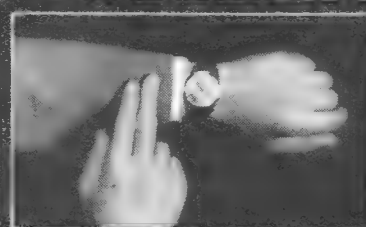


A paddlewheel moves marsh water in the Bonneville Salt Flats to an evaporating pool at a potash plant. Old wheel is used because salts clog modern pumps.

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THE MARK OF MAN

*As he moved about the globe
in his massive migrations,
he changed the face of the land*

Of all significant arrivals, man came last upon the earth. The fishes, insects, amphibians, reptiles, birds, mammals all had existed, perished, adapted and survived ages before modern man appeared some 40,000 years ago—a mere wink in the scheme of geological time. And, in a still briefer time—no more than 20,000 years—the newcomer has managed to leave his mark on virtually every corner of this minor satellite on which he happened to evolve. Whatever may have been his common ancestry with other primates, such as apes and monkeys, early man learned from his burgeoning intelligence that the stones and sticks apes used instinctively were far more useful sharpened into tools and weapons. So equipped, he left the apes dwelling in the forests (as indeed some still do) while he himself began to roam the plains and eventually plant crops. Thus the first of man's migrations began.

Even today they are still continuing. In the intervening centuries, the forthright need for food has influenced man in his wayfarings across the planet which gave him birth. And with him he carried the need for shelter, which was first satisfied simply by an overhanging bough, then later by a cave. Predictably, these proved inadequate, and he built dwellings of his own creation, ranging from ice huts which vanished in the summer's heat to

whole cities constructed almost completely of marble, whose magnificence has survived through the ages.

But simple food and shelter were not enough. Man found something in his nature, a soul or spirit, which itself craved sustenance and warmth. Not infrequently this inner voice, speaking in a thousand different tongues, dominated all other human considerations and man went to almost any lengths to build shrines appropriate to his particular religion. One of the most impressive is shown on the opposite page—a Buddhist temple hugging a 7,760-foot mountaintop in Ceylon.

Indeed, there is hardly a spot of land on this globe which has proved too difficult for man to reach. And invariably, he has left his mark behind—whether for good or evil. The golden temples, the swooping bridges, the soaring skyscrapers all were built by the hand of man, the same hands which tore open the earth to get at minerals, which befouled rivers and lakes, and which today threaten to devastate the globe with war.

In another 50 billion years our land will be locked in ice, and man's tenancy will have long since ended. By then, though, he may have achieved the ability to make a cosmic migration. For, whatever mark man has left on the earth, his finger is already scratching at the sky.



An awesome evidence of man is this mountaintop shrine astride the razor-back of 7,760-foot Sri Pada in Ceylon. It was built to enclose and preserve the sacred footprints of Buddhism's founder, Gautama the Buddha, or "the enlightened one." Every year, thousands of reverent pilgrims from all over southern Asia laboriously climb the mountain in an antlike stream to pay their respects to the gentle, thoughtful man who established what many consider one of the noblest philosophies ever embraced by the human spirit. Devout Buddhists hold the belief that every morning, out of deference to Buddha, the sun dips up and down briefly after it appears over the horizon.

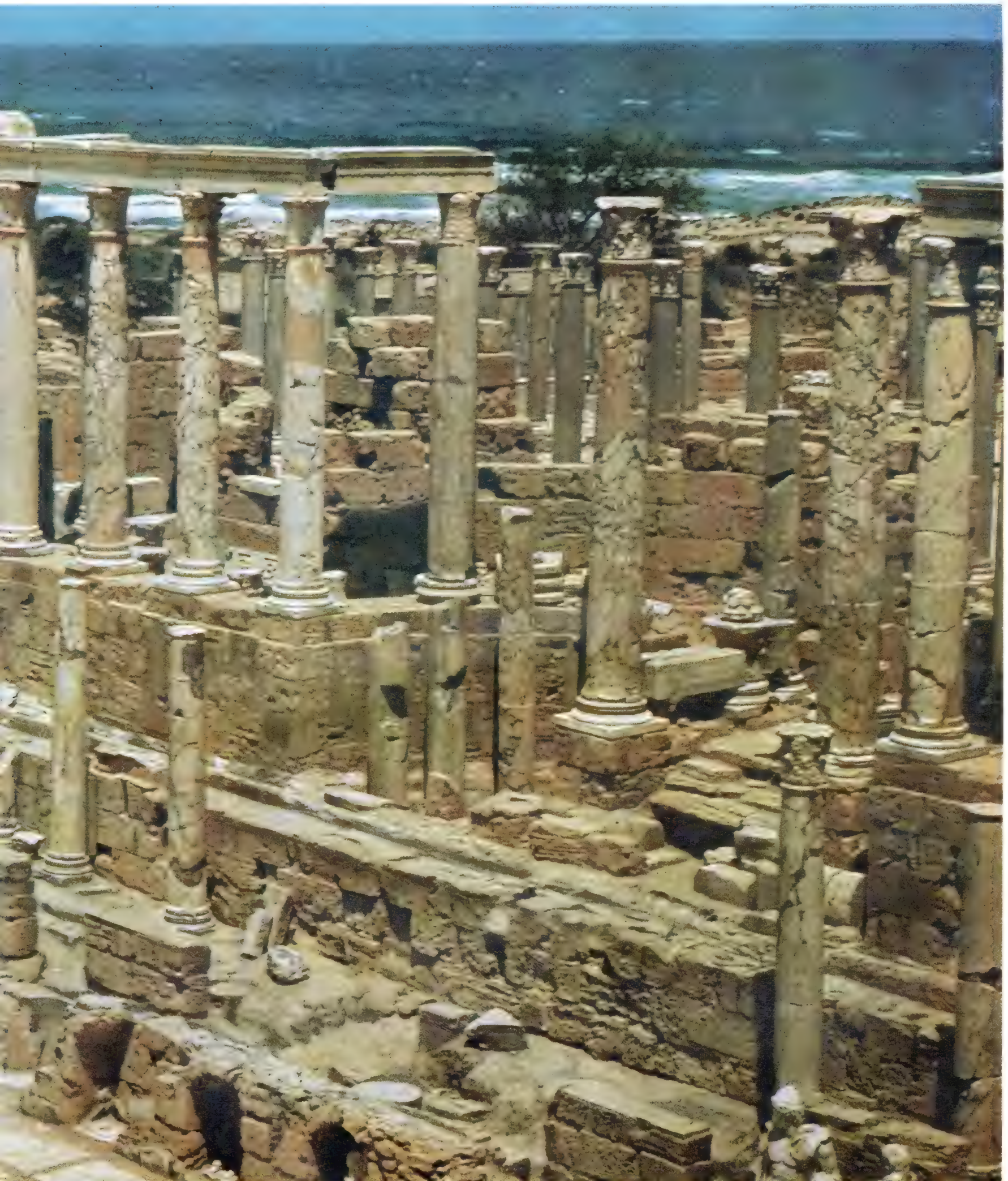
The enduring ruins of a great city



The splendid columns and graceful, curved theater of a magnificent marble city built in the first centuries after Christ still stand against the timeless background of the blue Mediterranean. These are the heroic remains of

Leptis Magna, a city in what is now Libya's Barbary Coast. Founded by the Phoenicians, Leptis Magna was later allied with Rome, during which time it became one of the most opulent cities in the empire. But Rome declined, and

still stand beside the timeless sea



so did Leptis Magna. In the Fifth Century marauding Vandals sacked the city. Its ruin was completed in 533 A.D. when the population fled to escape Berber raiders. After a brief revival under Justinian the relentless desert sands crept in,

choking off the streets until, by the 11th Century, the city had been inundated to a depth of 40 feet. Rediscovered and uncovered, Leptis Magna now represents one of man's noblest early achievements in construction and statuary.



A tenuous hold in a greedy jungle

Sometimes man must wage a constant battle to maintain a precarious hold on his bit of land. Here, in a deep valley of Dominica, in the West Indies, an adventurous planter protects his grove of lime trees (*center, left*) against the constant easterly trade winds with a semicircle of dense eucalyptus trees. The dank climate, luxuriant forest growth and rugged mountains have, for nearly 400 years, discouraged most planters from developing the interior of the island, and most inhabitants dwell along the coastline. Indeed, until three years ago, the only way to

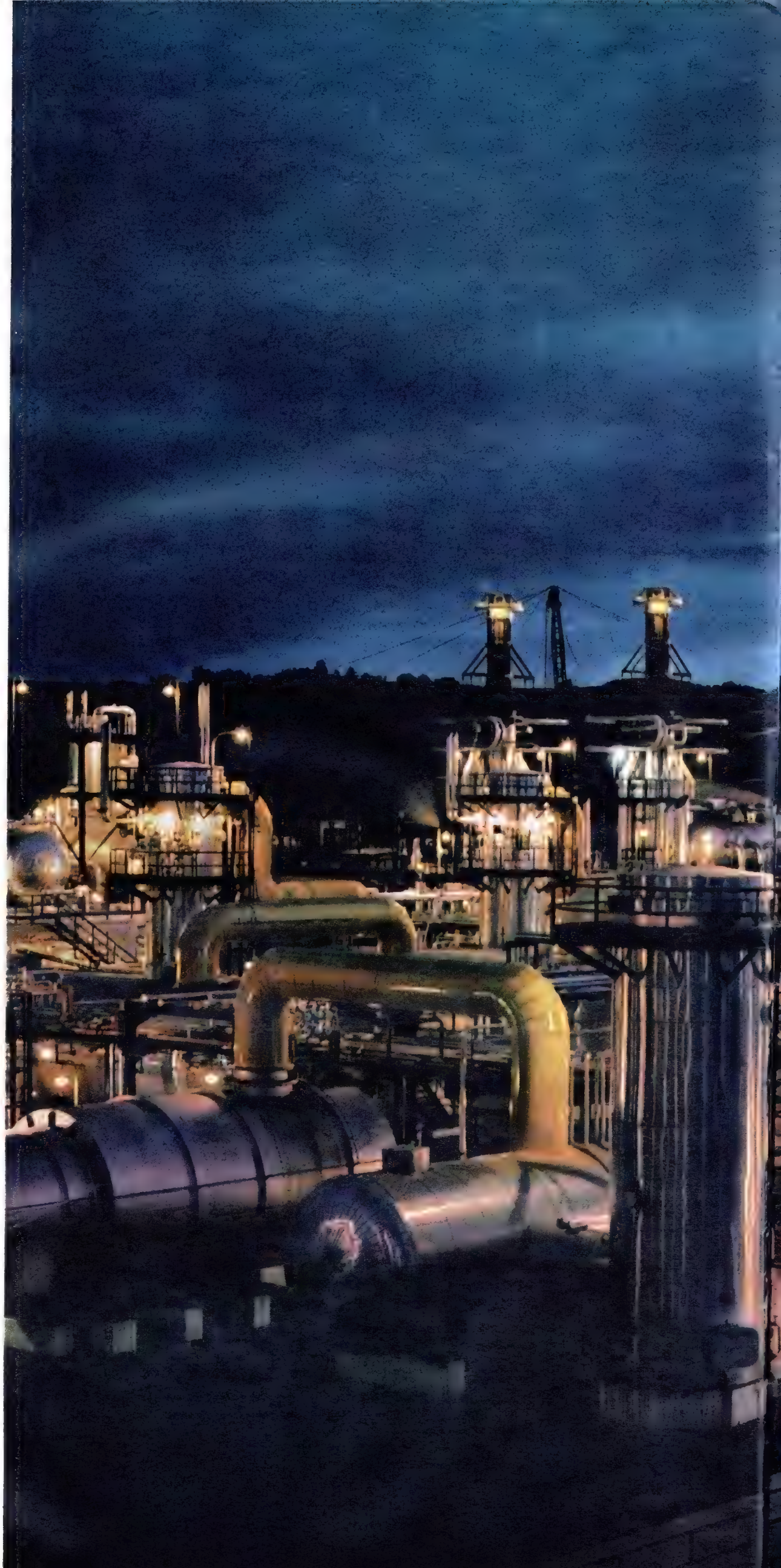


cross the island was by foot or on horseback. Isolated from its neighbors by the sea, its interior cut off by jungle and mountains, Dominica represents in microcosm the natural barriers which have influenced man's development and distribution everywhere. Yet it is in the nature of man that, regardless of how inhospitable a place may be, someone will choose to live there. Indians dwell on storm-torn Tierra del Fuego, primitive people still live in the almost waterless Australian bush, and a tenacious little band prefers the volcanic perils of life on the mid-Atlantic island

of Tristan da Cunha even after a taste of civilization in Great Britain. There are, however, compensations for the lonely existence shown here: on Dominica are found exotic birds which exist nowhere else on earth, along with oversize frogs and wild oranges, both of which make for succulent eating. But though this planter has made his hard-won mark on the land, it is at best only a transitory one. If he were to give up the fight, the greedy jungle would reinvade his patch; and within a few short years, virtually all signs of man would be obliterated.

A mark of utilitarian beauty

For uncounted centuries man dwelt upon the earth and did little more than pick at its surface. He found a suitable rock, chipped one edge to a sharp surface, and it became an ax or crude knife. Later he discovered copper and found that it could be hammered into useful shapes. But it wasn't until about 3,000 years ago that man discovered rocks which when melted left a residue that could be formed into implements of exceptional keenness. Thus the Iron Age was born, as man for the first time began to probe beneath the surface of his planet. Once started, the process has been unending, and the wealth waiting beneath the ground has proved to equal if not overshadow that found on the surface. There was brownish black rock which occurred in huge, seemingly endless deposits and which burned with undreamed of heat. There were tiny crystalline pebbles of unbelievable hardness which could be ground into sparkling gems. And there was an oily, greenish black liquid which has in its own way altered the face of the land—in straight highways across continents; in cities mushrooming on once-isolated wastes; and not least in such gleaming extravaganzas of tubes, pipes and towers as this natural gas plant near Lacq, in the French Pyrenees. Here even the means used to extract the earth's hoarded riches possess a utilitarian, esthetic beauty.









Close by the erosion-stunted bulk of Camelback Mountain near Scottsdale, Arizona, the lights of a sumptuous resort twinkle in the gathering twilight. Until a short time ago such desert locations would have been untenable by man. Now, thanks to irrigation, air conditioning—and swimming pools—they are not only livable but luxurious.



Roaring over the California hills, a fierce forest fire leaves a mark on the land that will be a blemish for years. Nine out of 10 such fires are man's fault.



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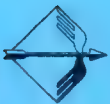
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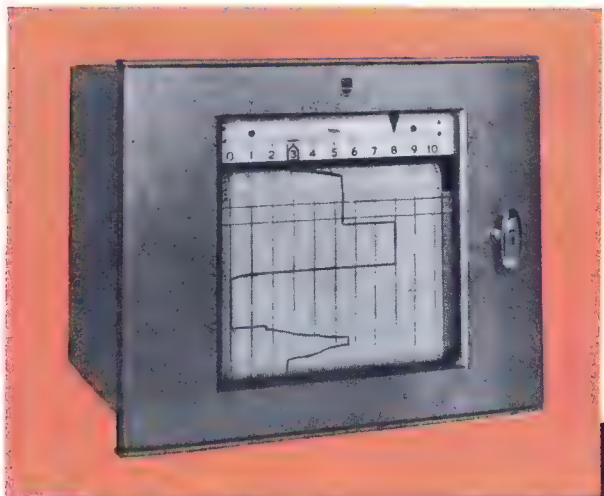
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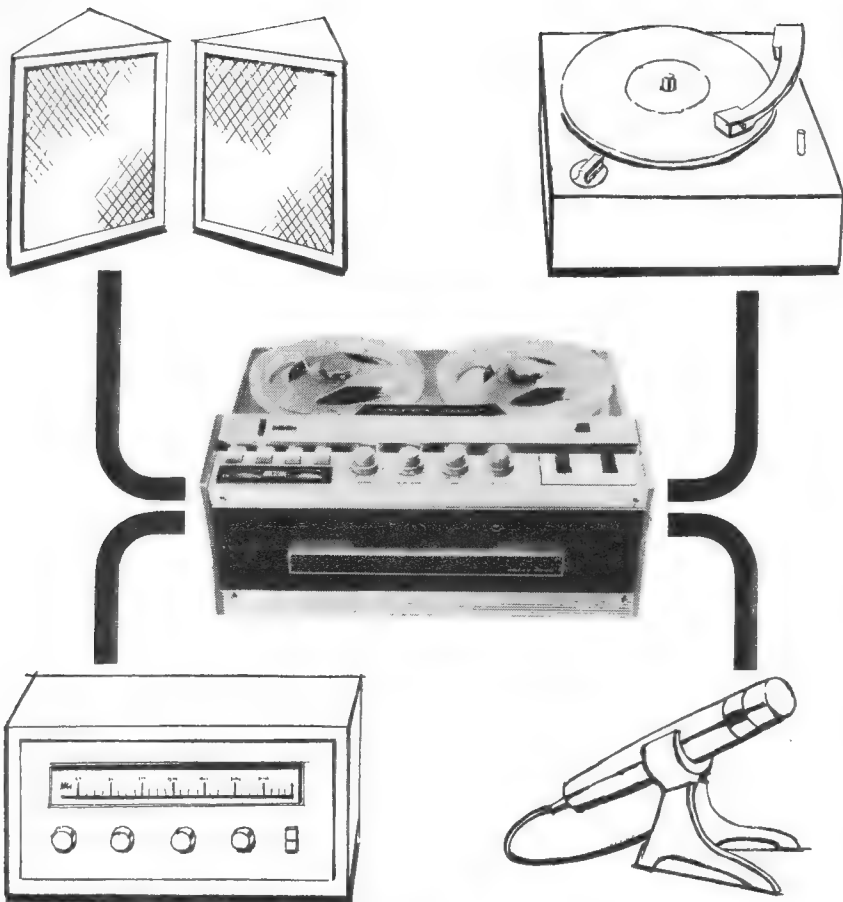
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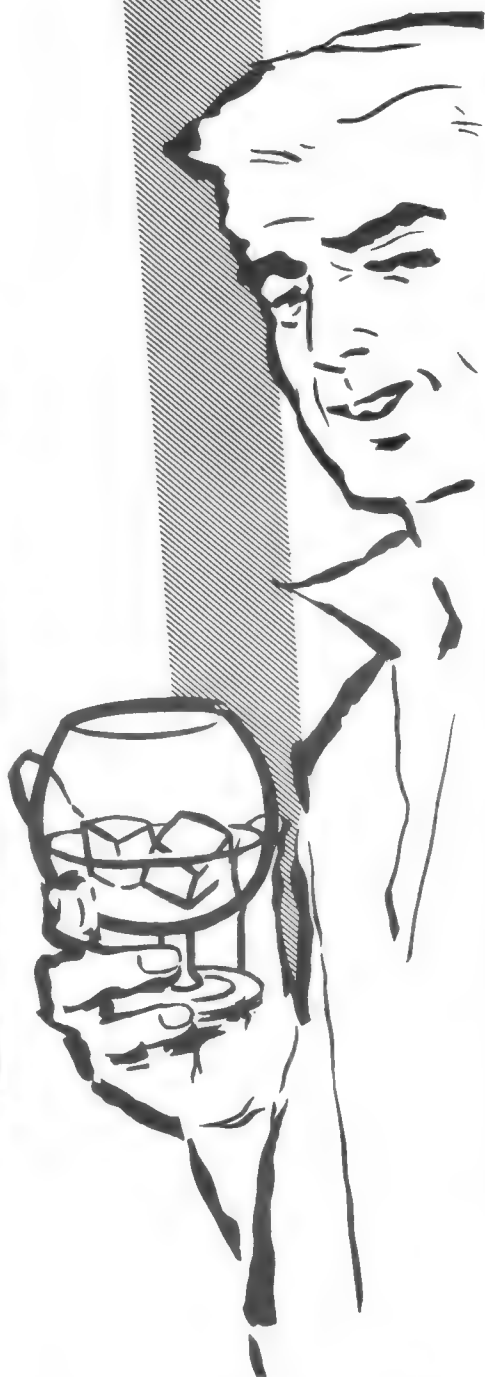
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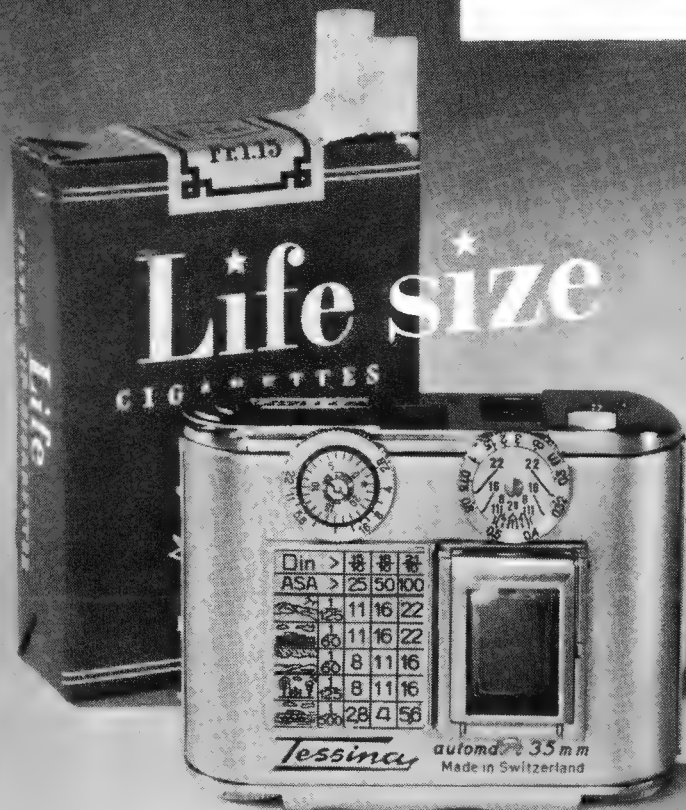
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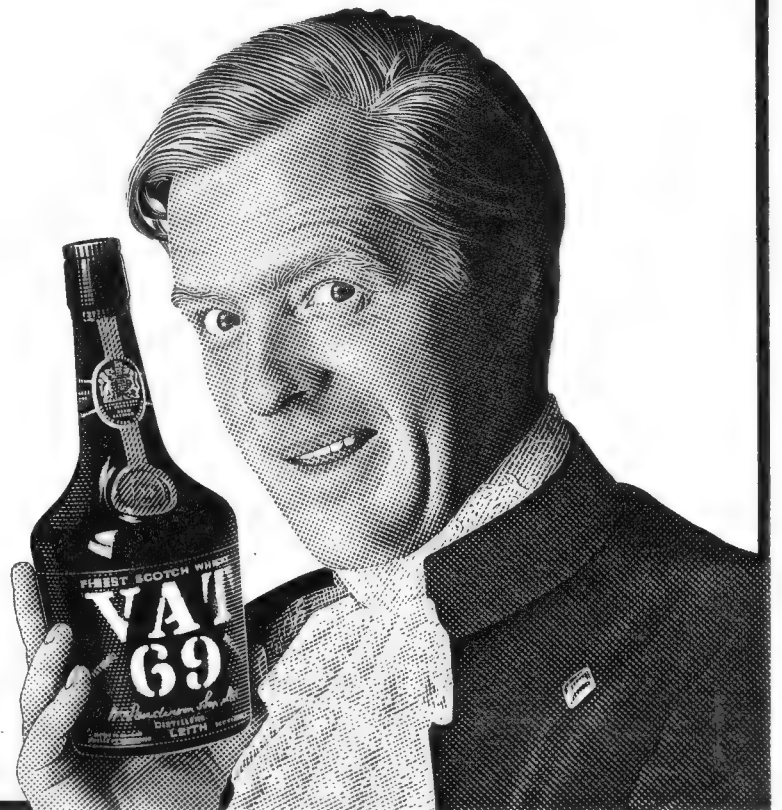
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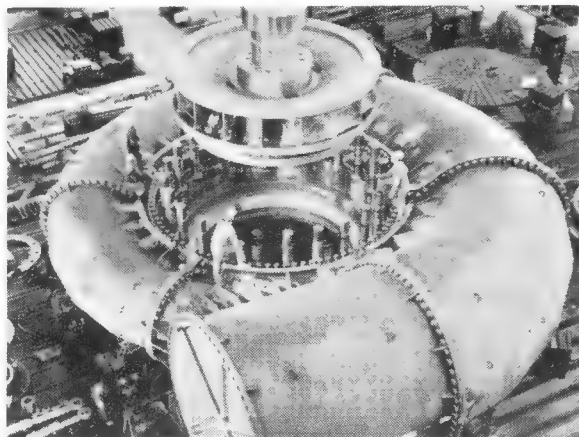
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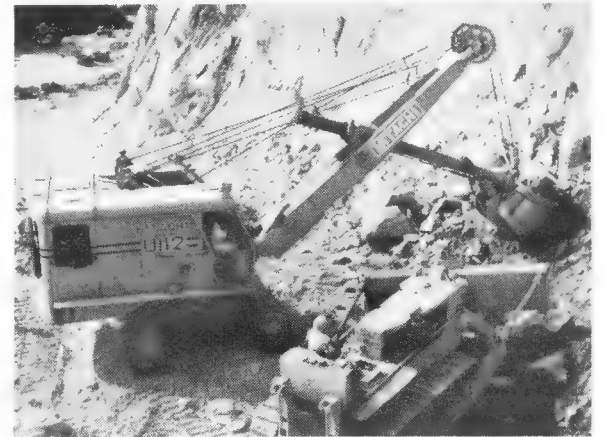
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THE ENDS OF THE EARTH

*Polar wastes
are a challenge
to every kind
of living thing*



Pack ice, jumbled by the immense forces of the tide and wind, covers the sea off the coast of Antarctica near the U.S. station at McMurdo Sound.

Among all the areas of our land, the polar regions are unique. They are in almost every sense the extremes of the earth. Their silent immensities are the most unearthly-looking places on earth—the domain of cold, the antithesis of life. They are vastly different from one another, truly antipodal. The North Pole lies amid a clashing jumble of pack ice which drifts around it in a clockwise spiral, in an ocean surrounded by the northern continents. The South Pole is situated on 9,200 feet of icecap and solid land, of roughly the same size and shape as the North Polar area, surrounded in this case by oceans. Their similarities are more obvious. At both ends of the earth, the accustomed rhythms of day and night are upset and strange lights disturb the sky. Both regions, remnants of the

Ice Age that gripped the earth one million years ago, show a perennial heat loss and are hostile to plants and animals. Yet all life on the globe is influenced by these enormous reservoirs of cold, for they send out their storms and tempering chill everywhere and shape the habitat that has nourished all life and every civilization. The geography of history has shifted since man has taken to the air. The world's most powerful nations ring the North Pole and nine out of every ten human beings live on the continents bordering the North Polar basin, which has thus become the new Mediterranean, the sea that is central to the world. Today the Arctic has become a highway; tomorrow both polar regions may be exploited for food and other materials needed for man's expanding population.



The world's largest compact mass of sea ice, the 160,000-square-mile Ross Ice Shelf, thrusts its northern edge into the Ross Sea some 750 miles from



On guard against attack across the North Pole, a radar station of the U.S.'s North American defense frontier stands stark and lonely in the vastness of the Greenland icecap. The task of supplying such outposts is giving the peoples of more temperate latitudes knowledge about living and working in the Arctic.

An arctic mirage, caused when a layer of cool air under a warmer, less dense one bends light rays in the manner of a lens, produces in a channel off the Labrador coast the image of rocks which actually exist many miles away. As the viewer approaches, the illusion ceases and the channel is clear.



the South Pole. The clifflike edge, from which tides break off icebergs, is 790-1,050 feet thick, only an eighth or a seventh of it above the water.





Adélie penguins in search of food troop across the antarctic ice. They start wandering at winter's onset, can go for six weeks without food.

A polar bear prowls across a Spitsbergen ice floe. This most carnivorous of bears can crush the skull of a seal with one blow of its paw.





The Rigors of Existence in the Harsh Polar World

Emperor penguins in the rookeries close by the American antarctic base at McMurdo Sound have been observed stolidly shielding their eggs in the teeth of a 90-mile-an-hour blizzard. Musk oxen on the west coast of Ellesmere Island, high in the Canadian Arctic, have been seen grazing calmly in 50°-below-zero F. cold. In such extremes, neither penguins nor musk oxen are in danger of freezing to death. Along with most other arctic and antarctic animals, they have an amazing capacity to function despite punishing cold and wind. The adaptations which make this possible are few and highly specialized. They relate to one of evolution's major developments: warm-bloodedness.

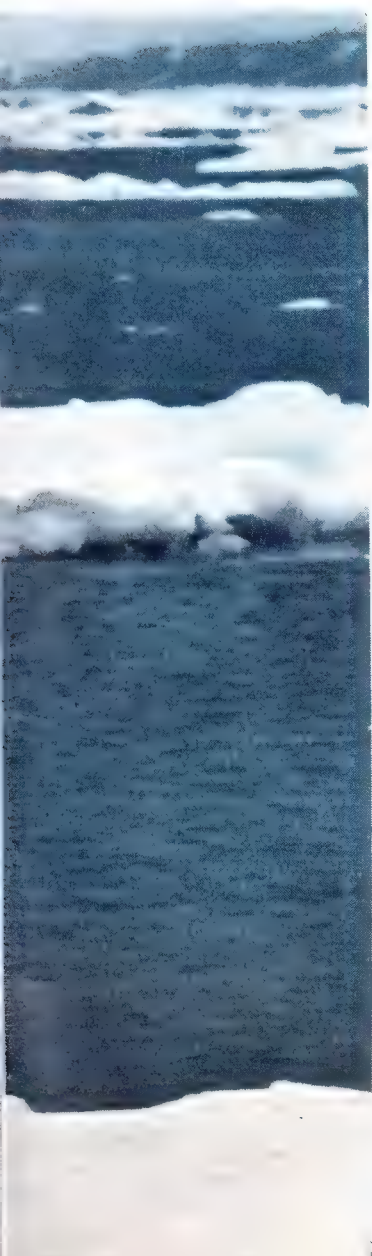
Wherever a homeothermic, or warm-blooded, animal goes it takes along its own private, internal climate. Whatever the weather outside (within limits, of course), its body basks in tropical heat, carefully maintained by a sensitive thermostat in the brain. Warm-bloodedness is an attribute of the higher forms of animal life, shared by all mammals and birds, including tropical ones, but its usefulness is most dramatic in the polar cold.

This intricate heat-control mechanism is relatively rare. There are about a million kinds of animals on earth and some 980,000 of them are cold-blooded, or poikilothermic. All of these—the reptiles, the fish and the insects, among many others—simply tend to take on the temperature of their surroundings; when it gets warm they are warm and active, and when it gets cold they are cold and torpid. A few of them can stay alive, though hardly functional, at fantastic depths of cold that would kill anything else, but almost all of them become inactive and helpless if

the temperature merely drops to about 40° F. or reaches about 108°. So the cold-blooded creatures, except for fish and insects, must leave the polar regions to the warm-blooded ones. For the flexibility that enables the warm-blooded animal to survive in climates far colder than its internal one, it pays a stiff price. Most of its food is used to generate heat. For example, even when a man feels comfortably warm he is using over half his calorie intake just to maintain body temperature. The colder it gets outside the body, the more food he needs. He is so ill-equipped for intense cold that he soon reaches a state where he cannot stay warm no matter how much he eats.

Man insulates his body with heavy clothing and shelter. Some animals are insulated with fur, fat, feathers or hair and take shelter too. Some hibernate in coldest winter, and others migrate to avoid it. Most striking of all the adaptations are those internal physiological processes which help conserve, tolerate and dissipate heat.

The animals' primary heat-preserving mechanism is insulation. It takes two forms: a layer of fat, or of tissue heavily impregnated with oil, just under the skin; and a layer of fur, feathers or hair just over the skin. Thus insulated, the penguin can frolic for hours in near-freezing water which would quickly kill a man. Just as a bird ruffles its feathers, a dog or wolf or fox can fluff out its fur to trap air and gain temporary warmth. It can reduce heat loss by modifying its shape, curling up in a ball to rest or sleep with nose and ears, paws and tail all tucked in. For better winter insulation the musk ox grows its inner matting of fine, long quiviut every fall; by the time the temperatures



THE POLES CONTINUED

drop and the winds rise, the animal is so effectively double-blanketed that the snow does not melt where an ox lies down.

Some animals maintain *two* internal temperatures, a tropical one for the body in general and a radically lower one for the extremities. This remarkable double standard of internal heating almost seems a step in the direction of cold-bloodedness—or in the direction of the animals that hibernate while their temperature, breathing and metabolism all decline. It is not easy to hibernate in the polar regions. The rodents cannot dig beneath the frost line. The lemmings, shrews, voles and weasels escape the cold by digging burrows in the snow. Next to the ground, at the bottom of the snow cover, temperatures remain generally warmer than the open air and within the burrows it is usually even warmer. The inhabitants have no need of hibernation. The ground squirrels, the marmots and some bigger mammals, up to the barren-ground grizzlies, curl up or den up and all but suspend life for the winter, while their body temperatures may drop nearly to freezing.

Other polar creatures, from caribou (and the wolves and wolverines that dog their trail) to ducks, protect themselves from the winter cold by migrating. Birds are the proverbial migrants of this world, and when winter comes to the top of the world flocks of waterfowl leave. The world's champion traveler is the arctic tern, the only species with homes in both polar regions. Every autumn it takes off and flies 8,000 to 10,000 miles down to the Antarctic—almost half way around the world—to find the icy open waters it likes. Then at the change of season it flies all the way back. Seven months of the year the tern is on the wing; it returns to its native rookery only for the nesting season. The golden plover is one of the Arctic's greatest navigators: three months after it arrives in the world as an egg, it can fly well enough to take off with its elders from the Alaskan beaches on an unerring, nonstop two-day flight to the Hawaiian Islands.

Despite their ingenious and near-perfect defenses against heat



All eyes and flippers, a Weddell seal pup sprawls on the antarctic ice. At birth a pup weighs 50-60

loss, all warm-blooded animals must lose some heat. They may live and even thrive in the coldest of climates—only so long as the food supply is ample. Like all animal life, the polar animals must get their food ultimately from the green plants.

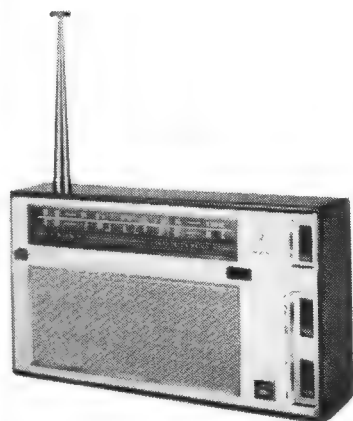
Plants need sunlight and air, water and certain minerals. In large areas around the poles, one or more of these raw materials is in short supply. But these shortages are no more critical in the lives of the plants than is the cold. For plants, much in the manner of the cold-blooded animals, take on the temperature of their environment, and the complex chemistry of photosynthesis and growth, like all chemical processes, seems to slow down as the thermometer goes down. Even the simplest plants of the polar regions must have a few days each year when the temperature is above 32° F., and the more complicated plants need several weeks of frost-free weather to survive.

The Antarctic knows no such luxury as frost-free weeks. The most successful plants in the Antarctic are the simplest ones, the

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pounds and is about four feet long. It may grow to be nine feet long and weigh almost 900 pounds.

algae and lichens and mosses. The lichen is supreme in the antarctic flora. Actually it is not one plant but two, an alga which carries on photosynthesis and a fungus which cannot. The fungus plays a multiple role: it anchors the feeble algae cells to the rocks, and its fibers hold moisture, which gives the algae a better water supply than if they lived alone. The mosses, not quite so sturdy, may grow only after lichen bodies have formed a thin soil.

Surrounding the continent from 300 to 1,200 miles offshore is a strip of water averaging 28 miles in width. This band of water is the so-called Antarctic Convergence, a region where relatively warm water flowing south encounters the colder mass of northward-flowing water from Antarctica. Where they join is a flourishing expanse of floating, speck-sized plants, which are called the phytoplankton. Drifting along in these icy seas is the enormous swarm of infinitesimal animals which, together with the floating plants, make up the plankton. In the green pastures of the polar oceans, tiny crustaceans and fish devour the plankton by the bil-

lions, until they are caught and eaten by larger fish and squids. These, in turn, will be eaten by penguins, petrels, seals and whales. The whales are the largest predators of all.

In the entire region south of the Antarctic Circle there are fewer than 70 species of animals. Forty-four of these are insects, of which the largest is a wingless mosquito. This is an astonishingly small insect population for such a vast area, considering that nine out of 10 of all the world's animal species are insects. There are no land mammals at all. Birds include the South Polar skua, the Adélie and emperor penguins, the antarctic tern, the southern black-backed gull, and six kinds of petrels. Sixteen other species of penguins live in somewhat milder climates to the north.

All of the penguin species have the same basic design: a streamlined body formally attired in stubby black and white feathers. The front appendages of the bird have evolved into swimming flippers covered with feathers that are almost scalelike.

As spring comes the Adélie penguin, most numerous of the species, waddles over the ice pack to the land's edge to breed. The bird fashions its nest out of pebbles—there is not much else available—and one of the traits that has endeared it to explorers is its use of the pebbles in its courtship. The male will solemnly present the female with a pebble, usually one it has stolen from another penguin's nest. This has its humorous side but the pilfering of rocks is really a matter of life and death for the penguin young, since an adequate nest for the parent to stand on is all that keeps the delicate egg above the level of the cold melt-water on the ground under the adult's body. Adélies will stay on their nests for the weeks of incubation, through fair weather and foul. Occasionally a whole rookery will be blotted out by a blizzard. The penguins do not move from their posts, but stay put in the snow, refusing to abandon their eggs until almost buried alive. During all the time that the eggs are being hatched, the parent on guard—sometimes the male, sometimes the female—goes without food, living on its fat against the time when it can again fatten up on fish.

The intermediate links in the long antarctic food chain are often bypassed by the whales. One large group, the baleen whales, which have no true teeth, feed directly on plankton, straining it

CONTINUED



DETAIL FROM A HEAD BY MICHELANGELO

4 classical features tell us whether a scotch is merely good or really great—its nose, its taste, its character and its colour. The colour of scotch is the visual promise of its sense of balance, its rightness, its greatness. Grant's looks good to people who recognise a great whisky when they see one—they see in it the colour of old sunlight, a pale, evening gold put there during the years it spent maturing in old oaken sherry casks. It is a scotch in which vigour and maturity have come to the perfect understanding.

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THE POLES CONTINUED

out of the sea water with a bony sieve hanging from the roof of the mouth. The full-grown blue whale, at 150 tons the most monstrous creature that ever lived, eats its way through three tons of krill, a two-inch, shrimplike crustacean, every 24 hours.

In the Arctic, remnants of a half-dozen whale species survive. Whales were never so numerous in the north, possibly because the Arctic Ocean is only intermittently paved with plankton.

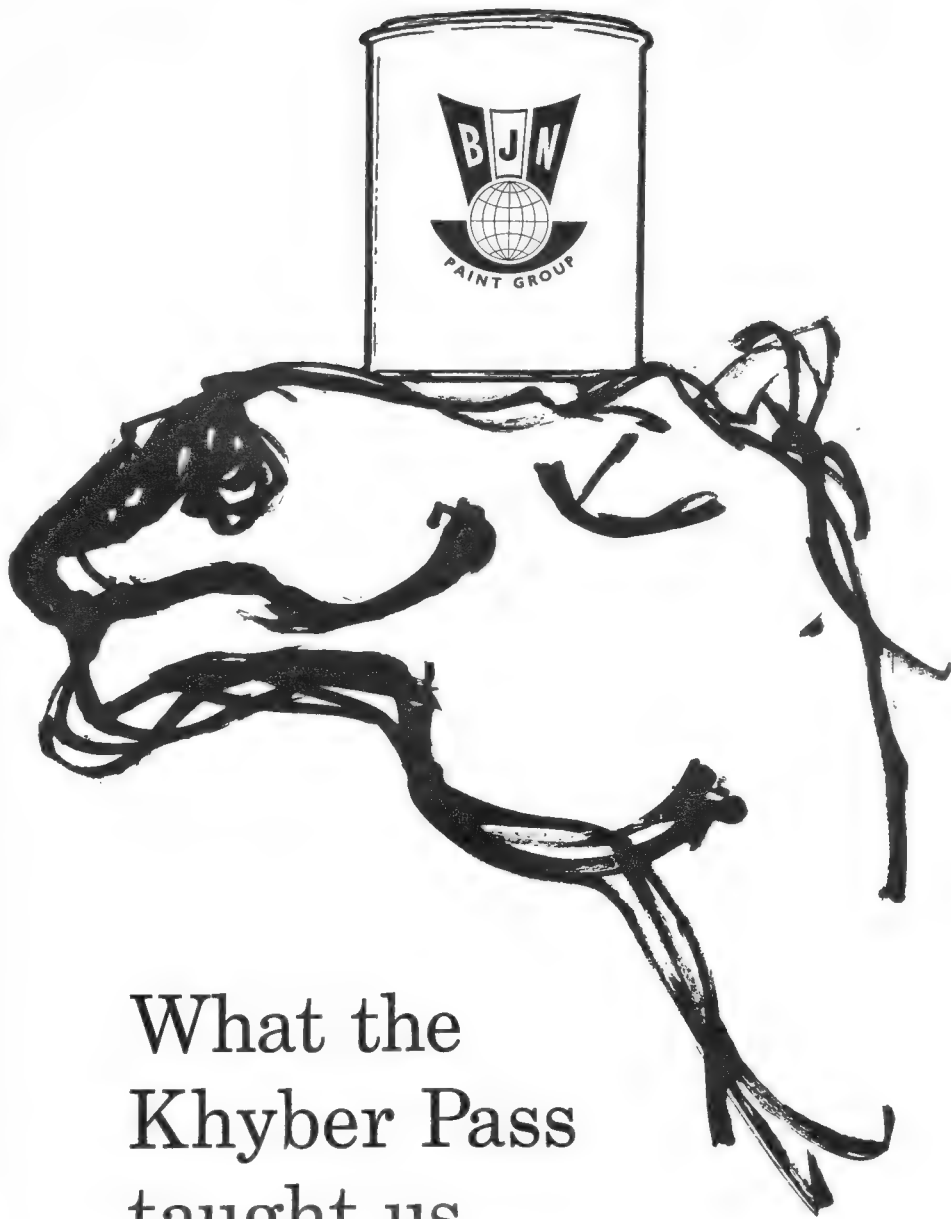
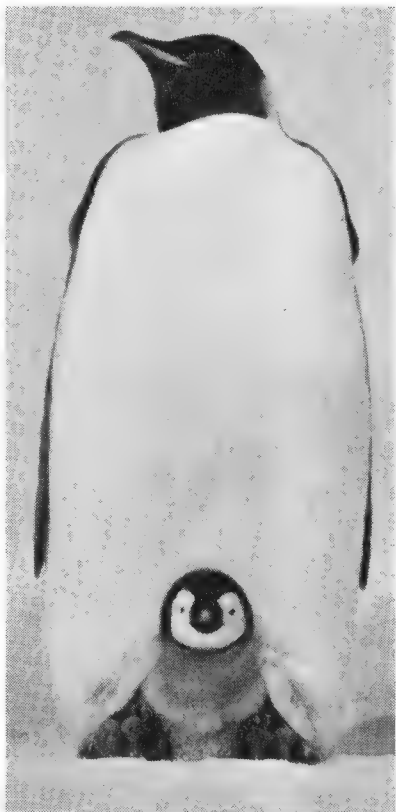
Of the warm-blooded species that have returned to the sea to escape enemies or find more ample food, the pinnipeds—fin-footed mammals—are by far the most prolific, probably the world's biggest population of big carnivorous animals. There are three families of them. The eared seals, including sea lions and fur seals, most closely resemble land mammals. They and the walrus (from the Swedish *hvalross*, which means "whale horse") have back flippers which can be used for "walking" on ice or land. In the third family are the earless, or true, seals, sometimes known as hair seals and including all the pinnipeds which dwell in the Antarctic. Their flippers are bent backward for better swimming, so they move awkwardly when out of water. The whales and the seals of the Antarctic all have their relatives in the north. One is the walrus, a huge, strong and streamlined diver that plunges as deep as 200 feet to root out shellfish with its two-foot tusks.

An implacable enemy of the arctic seals is the formidable polar bear. It is without any exception the most familiar of the polar creatures—almost any child can draw one—but its life cycle was long something of a mystery. Polar bears are tireless swimmers, gaining buoyancy from their fat and their dense coats of oily fur, and have been seen paddling away 25 miles from the nearest land. Just as the penguin would seem to be the antarctic animal most likely to succeed in the Arctic Ocean (though there are none), the polar bear would appear to be the one animal that would stand the best chance of surviving a transplant to the far south. It is to be seen wherever three things are found together in the Arctic: cold water, sea food and pack ice. Besides seals, the polar bear eats young walrus, fish, stranded dead whales, birds' eggs, and some seaweed. Occasionally it may abandon the ice, go a short distance inland and, like any bear, eat berries, grasses, and rodents.

A pregnant female bear becomes dormant in a cave on the ice, giving birth to its cubs—generally two every second year—in midwinter. The cubs of a 700-pound mother weigh only two pounds at the most at birth and, depending on how the hunting goes upon the ice, may or may not ever set foot on land during their lives.

The southern limit of the polar bear's immense range is the edge of the drift ice. As for the northern limit, the first thing the lookout on the nuclear submarine *Skate* saw when his vessel surfaced close to the North Pole was a polar bear ambling along nearby.

A baby emperor peers from its nestling place under its parent's warm fold of abdominal skin. For its first few weeks it will ride on its father's or mother's large flat feet.



What the Khyber Pass taught us about PAINT

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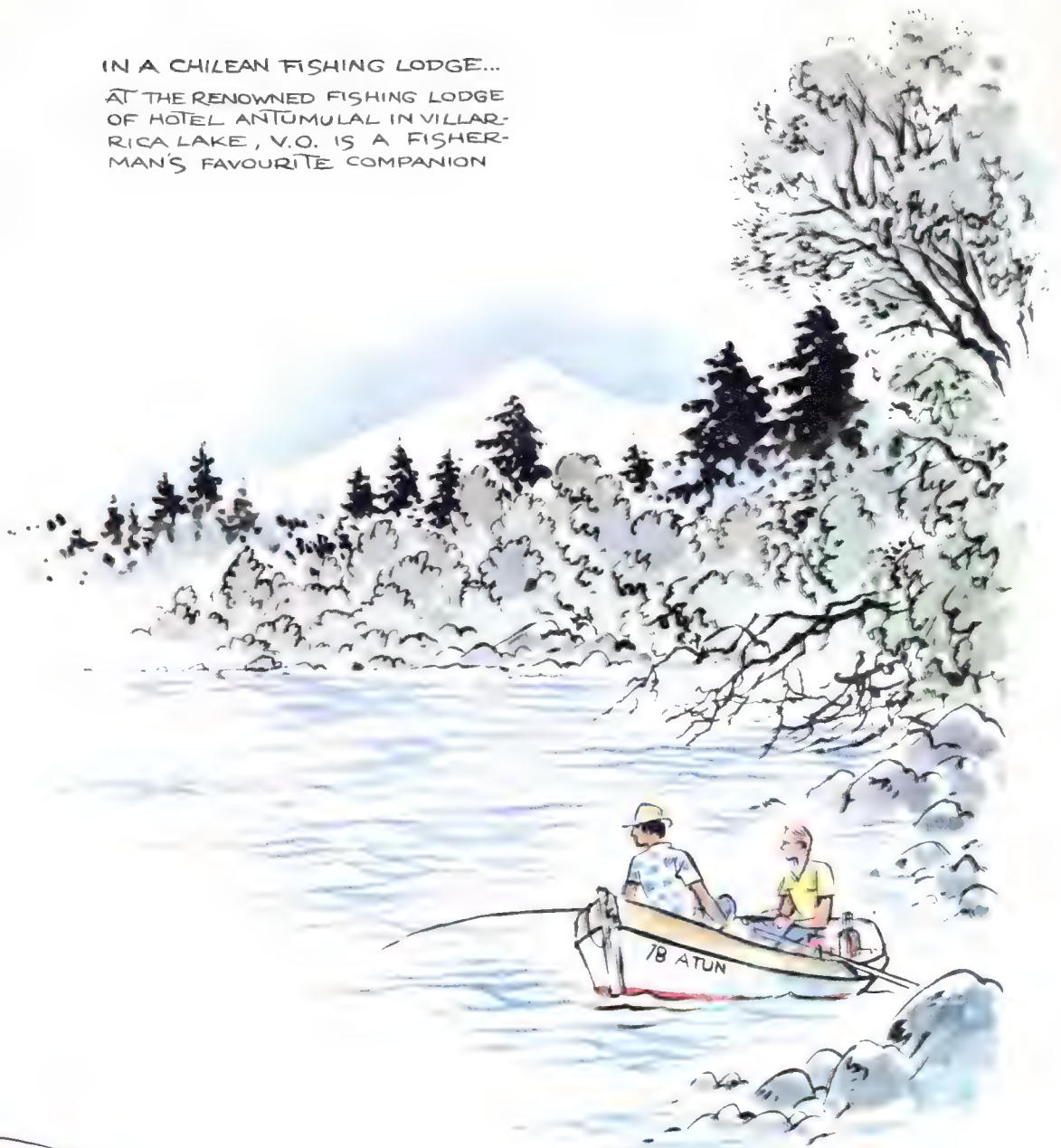


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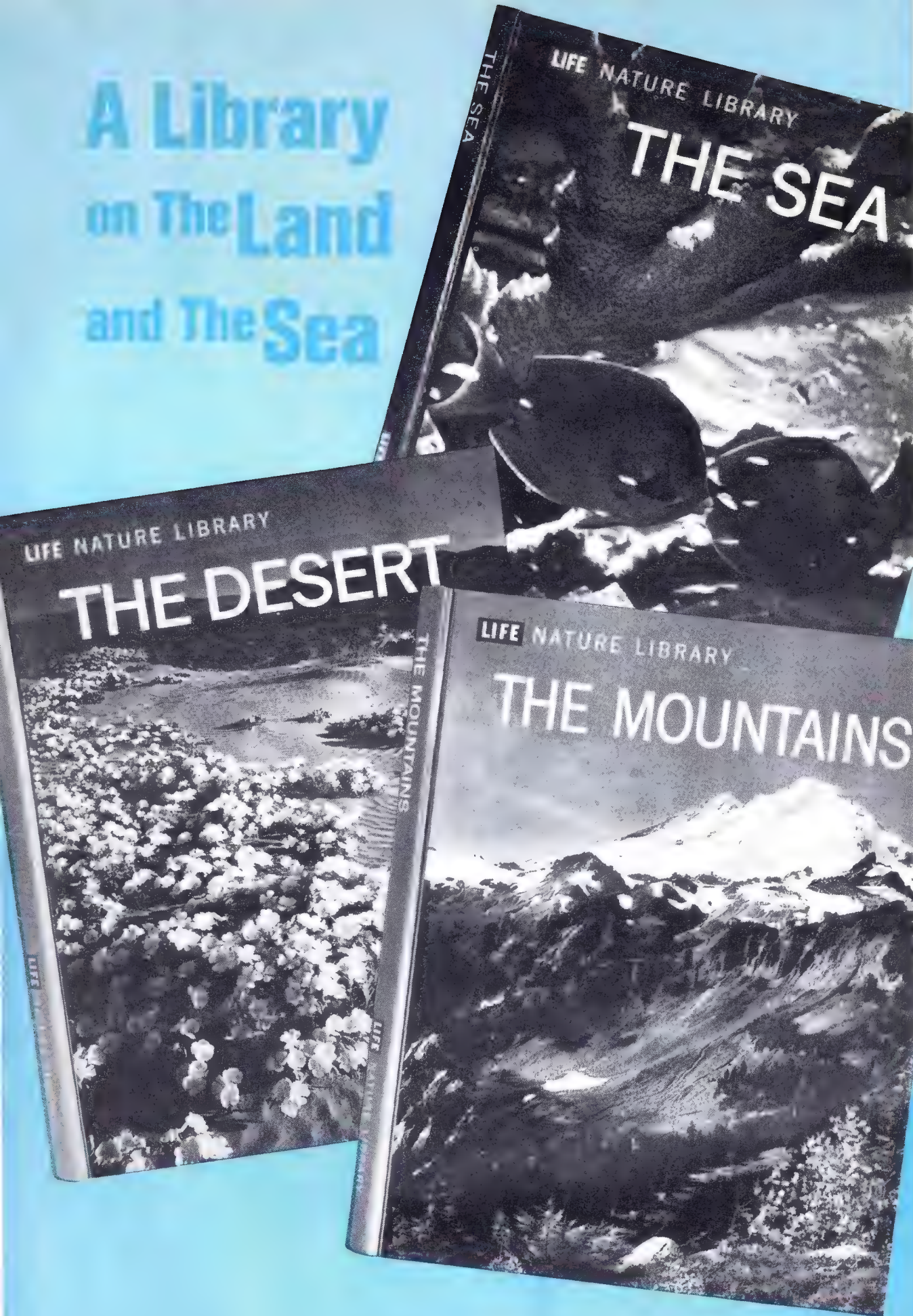


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A Library on The Land and The Sea



Even a double-size issue of LIFE, like this one on The Land and the issue devoted to The Sea (LIFE International, Jan. 28, 1963, Vol. 34, No. 1), cannot cover the entire scope of so huge a subject as that of our earth. But readers who want to know more about the land and the sea should be interested in a series of books (above) being issued by the Editors of LIFE, entitled the LIFE Nature Library. Already published are *The Sea*, with text by Leonard Engel, *The Mountains*, by Lorus J. Milne and Margery Milne, *The Desert*, by A. Starker Leopold, and *The Poles*, by Willy Ley. Besides 30,000-

40,000 words of informative text by these eminent authorities, the LIFE Nature Library books also contain scores of photographs, paintings, maps and charts, many of them in full color. Those already published in English have been or are being translated into Japanese, Norwegian, French, German, Dutch, Swedish, Italian and Spanish. They should be available at your local bookseller; if you cannot find the volume that you want, write to Time-Life International, Keizersgracht 590, Amsterdam-C, Netherlands, and we will reply, telling you where you can purchase these volumes of the LIFE Nature Library.

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Abundant harvests!

Perhaps the most pressing problem we face today is feeding the ever expanding millions in the world's "exploding" population. And now from Esso: a new agricultural plan to improve farm yields and increase food production. Its name: the Esso Soil Enrichment Program. Featuring two all-new Esso fertilizers—Engro Complex and Engro Urea—and extensive technical assistance from Esso agronomists. Already under way in Latin America the plan will soon be introduced in other countries throughout the Free World. Perhaps another reason why Esso is the **World's First Choice!**

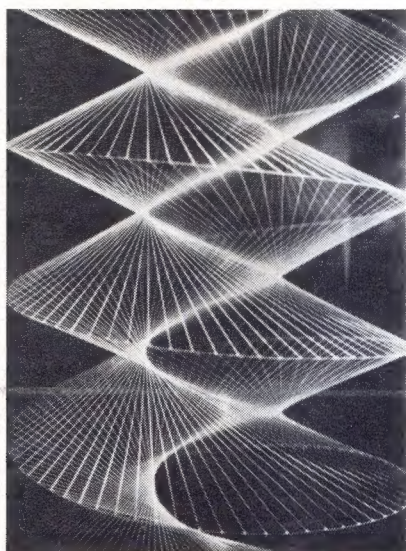


Some Big Things Coming in **LIFE** INTERNATIONAL

An aerial photograph of a Greek hillside town, showing a dense cluster of white-washed buildings cascading down a steep, dark hillside towards a blue sea. The town is built on a hillside, with the buildings packed closely together. The sea is visible in the background, and the sky is a deep blue. The overall scene is a classic Mediterranean coastal town.

A line of bright, white houses, spilling down a Greek hillside toward a blue sea—this is among the spectacular sights that will appear in a LIFE International issue devoted to Europe. The issue (Aug. 12, Vol. 35 No. 3) will include a guide to these Greek Isles, a timetable of August events in Europe, a panorama of the marvelous vistas of Europe, plus many other picture stories and articles in praise of this favorite area of international travelers. The issue devoted to Europe is only one of many other major projects now being planned for LIFE International's readers. For some of the others, turn the page.

On the Editors' Planning Board



SCIENCE

Mathematics made easy, matter, electricity—even some helpful tips for playing games of chance.

THE ARTS

Rodin (left), Leonardo, Shakespeare, the Literary Landscape series (Kipling, Melville, Jack London).



CHRISTMAS

Toys to make, games to play, the lore and legend—all in a special section planned for a Christmas issue.



THE WORLD

Alliance for Progress, the new Japan, Europe's economy today, the U.S. as only LIFE can cover it.

PLUS THESE BIG ONES

TRAVEL, 1964. For the biggest travel year in history, two special issues: "The New World," travel in Western Hemisphere, including the New York World's Fair (next year's first issue); "Travel in Asia," plus the Olympics in Japan (next summer).

MOVIES. A special issue on cinema around the world (next spring).

RUSSIA. A spectacular special issue (this fall).

OTHER SERIES. Continuing "The Human Body," "Great Families of Europe," "Where To Study Abroad," "Cities of the World," "The Creative Adventure."



HISTORY

Series on World War I (left), the story of Bolívar, continuing the series on "The Heritage of Greece."



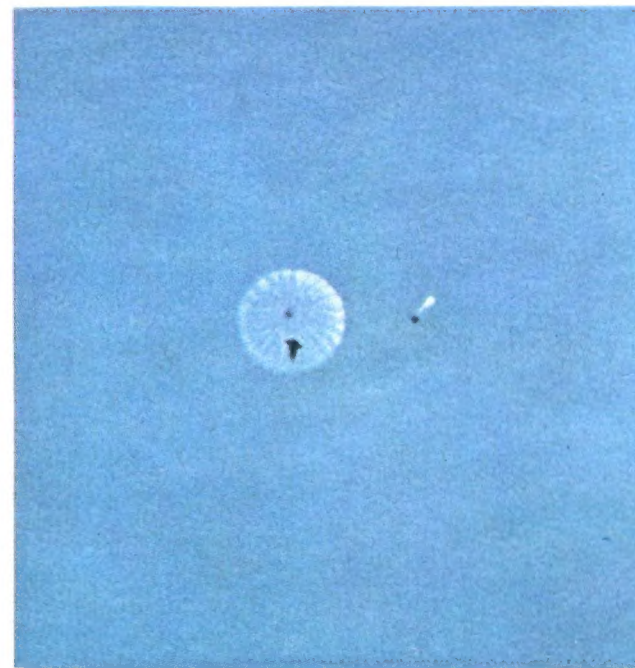
Another adventure in one of the 87 lands where Canadian Club is "The Best In The House."[®]

Danger was my jumping partner a mile high over France

1. "Danger always has the drop on you when you jump from a plane," writes Allen Churlet, a friend of Canadian Club. "But when you leap arm-in-arm with a partner, as they do in France, it's double jeopardy all the way down. The idea is to stay right-side-up until it's time to open your chute. Then push away from your partner . . . and pray your chutes won't tangle. A split-second error can spell disaster."



2. "We crawled out on the wing. It was slippery. The angry wind clawed at me, trying to spill me over. My every fibre urged me, 'Go back!' But it was too late. The only way out was down! I had to go through with it now."



3. "Desperately, I clutched my partner, and down we went. An eternity passed as we fell. At last he yanked his chute ring. I shot by him like a rock. A year ticked off before my chute blossomed. What a relief!"

4. "Later, my friend invited me for a drink of his favourite whisky . . . and mine . . . Canadian Club!" Why this whisky's universal popularity? No other whisky rewards you with such distinctive flavour—for no other whisky tastes quite like Canadian Club. You can stay with it all evening long—in short ones before dinner, or in tall ones after. You owe it to yourself to start enjoying Canadian Club—the world's lightest whisky—this very evening.



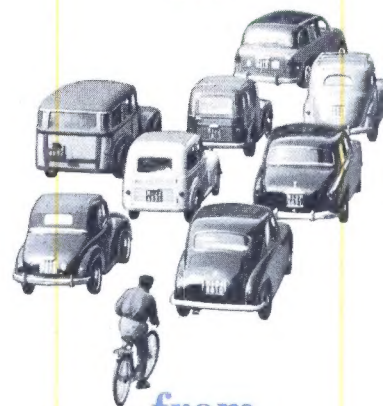
Canadian Club

In 87 Lands . . . "The Best In The House"

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